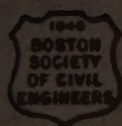


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ONE FACTOR OF HIGHWAY TRANSPORT

PRESIDENTIAL ADDRESS BY ARTHUR W. DEAN,* BOSTON SOCIETY OF CIVIL ENGINEERS,
MARCH 21, 1934

I AM not going to bore you with a long and tedious address, but hope to interest you more by showing pictorially some of the activities in the maintenance of highways, which constitute an important factor in highway transport.

A quarter of a century ago, if an average family wished to move its household goods a distance of thirty miles, there were required about five horse-drawn vehicles to make the transfer. This condition has gradually changed. The five horse-drawn vehicles are in the discard, and one large motor truck is substituted. The motor truck, however, requires a smooth, substantial road, which must be kept in a smooth and proper condition at all seasons of the year. The maintenance of this condition of the highways is the subject matter of this address.

First, let me say that the movement of household goods is mentioned simply because it is an outstanding example of door-to-door transportation of loads of comparatively light weight, and the distance, thirty miles, was and is the approximate maximum distance for a one-day trip of a horse-drawn vehicle. Instead of the original single load of about one ton, we now have legal loads of fourteen tons or more, and numerous illegal loads weighing sometimes as high as twenty tons.

Modern highways, if properly built, sustain such loads, but nothing on earth remains permanent, and therefore the highways must be properly maintained by some sufficient means, and it is with this proper maintenance of highways for transport of persons and property that

* Chief Engineer, Massachusetts Department of Public Works, 100 Nashua Street, Boston, Mass.

essential facts are now presented to you, pertaining particularly to Massachusetts, but applicable to all States and counties having well built and maintained highways.

There are several component factors in the work and expenditures for maintenance: the road surface, the shoulders, the underground drainage and the surface drainage, the roadsides, including trees, grass

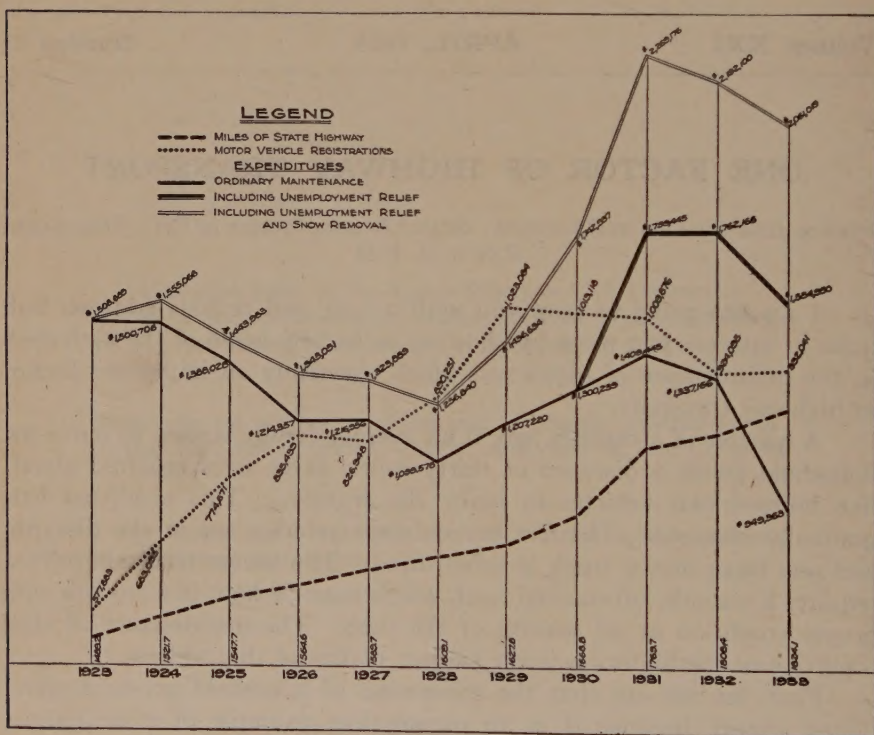


FIG. 1

and shrubs, the slopes in cuts and on embankments, the guard fences, traffic signals and lines, guide boards and route numbers, and last, but not least, the removal of snow and the sanding of slippery surfaces in winter.

The methods of surface maintenance vary with the type of surface. The predominant road surfaces in Massachusetts are cement concrete and bituminous macadam. A defect in a cement concrete surface is remedied temporarily by putting on a disfiguring bituminous patch, and

permanently by removing a square of the concrete and replacing with the same material. A defect in a modern bituminous macadam is remedied by so-called paint patching, or by removing the penetrated layer and replacing it with new stone and bitumen. The same methods of repairs are used in bituminous concrete.

The Massachusetts Department of Public Works has created and expanded an organization which, with the exception of a few executives, devotes all of its time to the maintenance of the State's highways. The State is divided into seven districts, each with an engineer in charge,

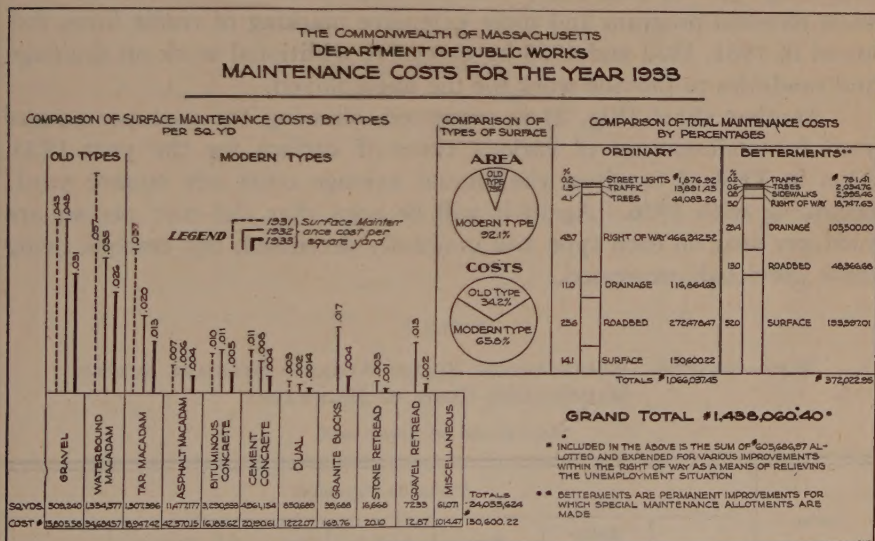


FIG. 2

and each district is again subdivided in such manner that there is a maintenance foreman in direct charge of approximately thirty miles of State highway. Each of these maintenance foremen has charge of a small crew permanently employed, which is enlarged temporarily when necessity requires. These crews are provided with necessary transportation, small equipment and materials. By this arrangement each mile of State highway is visited daily, and any defect discovered receives immediate attention.

The Department keeps a careful record of the cost of maintenance of the various types of surface, as well as the cost of upkeep for shoulders, drainage, roadside work and other items.

A very interesting chart (Fig. 1) is here presented, showing the total mileage of State highways and their yearly maintenance costs, as well as the number of motor vehicle registrations in this State from 1923 to 1933, inclusive. An interesting feature of this chart is the gradual increase in total mileage of State highway, but a decrease in the total cost of surface maintenance. This decrease is due to the reconstruction and substitution of modern types of pavement and widening of old surfaces, and by increased skill of the maintenance forces. The chart contains an additional curve showing cost of maintenance and operation beginning with the year 1929, when the Department started an extensive snow removal program and more extensive marking of traffic lines, followed in 1931, 1932 and 1933 by extensive additional work on drainage and roadsides to provide work for the unemployed.

Another chart (Fig. 2) is presented, showing the cost per square yard for maintenance of various types of surface for the year 1933. Also, in Table I is given the annual average costs per square yard, beginning with 1926. Again it will be seen that the cost per square yard per year on each type has gradually decreased, the reasons being those previously expressed.

TABLE I

MASSACHUSETTS DEPARTMENT OF PUBLIC WORKS — ORDINARY SURFACE
MAINTENANCE COSTS OF HIGHWAYS

[Average cost per square yard]

YEAR	TYPES OF PAVEMENT						
	Gravel	Water-bound Macadam	Tar Macadam	Asphalt Macadam	Bituminous Concrete	Cement Concrete	Dual*
1926 . . .	\$0.0718	\$0.0680	\$0.0343	\$0.0175	\$0.0134	\$0.0123	\$0.0343
1927 . . .	.0500	.0527	.0475	.0197	.0129	.0123	.0042
1928 . . .	.0749	.0575	.0419	.0158	.0115	.0146	.0054
1929 . . .	.048	.059	.046	.014	.009	.017	.008
1930 . . .	.059	.057	.031	.010	.011	.014	.005
1931 . . .	.045	.057	.037	.007	.010	.011	.003
1932 . . .	.045	.033	.020	.006	.011	.008	.002
1933 . . .	.031	.026	.013	.004	.005	.004	.001

* Two strips of cement concrete with middle strip of bituminous macadam.

To show that snow removal and the sanding of ice is an important element of expense, a tabulation of 1933 costs paid by the State has been

prepared. The average snowfall in the State for that year was 66 inches, and the cost of plowing was \$139.97 per mile, and of sanding, \$137.56 per mile. These combined figures amount to approximately 54 cents for each registered motor vehicle. Present indications are that the costs this year will be about 30 per cent greater.

The balance of the address consists of remarks explanatory of moving pictures showing different methods and operations involved in the construction and maintenance of highways, including snow removal.

THE CAPE COD CANAL AND THE NEW HIGH-LEVEL BRIDGES

A Symposium

(Presented at a meeting of the Boston Society of Civil Engineers held on January 24, 1934)

GENERAL OUTLINE OF THE CAPE COD CANAL AND BRIDGES

BY LIEUT. PETER P. GOERZ *

THE subject of tonight's series of talks is the Cape Cod Canal and the new high-level bridges. Many published reports are available on the construction and operation of the canal, so my part of tonight's presentation will be confined to a brief review of the history of the present project and especially as it applies to the new bridges. The district engineer early obtained the expert services of two consulting firms, Fay, Spofford & Thorndike, and Parsons, Klapp, Brinckerhoff & Douglas, for the design of and supervision of construction of the two highway bridges and the railroad bridge, respectively, and of the Massachusetts Department of Public Works for the proper connection of the bridges with the Commonwealth's splendid highway system. Mr. Carroll A. Farwell of Fay, Spofford & Thorndike, will later speak of the design and construction plans for the two highway bridges, and Mr. Andrews of the Department of Public Works will present the Commonwealth's plans for the highway connections. Mr. Sellew will tie into the scheme the new State Pier at the Buzzards Bay end of the canal.

EARLY HISTORY

The early history of the commercial use of the route followed by vessels using the canal today is fascinating. To avoid the shoals and fogs, with their attendant dangers and delays of the several outside routes around Cape Cod, projects for a trade route via Buzzards Bay had been proposed for nearly three hundred years; in fact, a canal

* Corps of Engineers, United States Army, Rivers and Harbors, District Engineers' Office, Custom House, Boston, Mass.

across the neck of Cape Cod has been longer under consideration than any other public work in the United States.

The first use of this route for commercial purposes was made by Miles Standish in 1623 when he ascended the Scusset River, a small stream that flowed into Cape Cod Bay about twenty miles south of the Pilgrim settlement at Plymouth, and, after crossing the narrow intervening low ridge of sand, met vessels of the Dutch traders from New Amsterdam, who had ascended the Monument River from Buzzards Bay. From this beginning there was established a regular traffic between the Dutch and English colonists. The land separating the rivers being only three miles wide it was but natural that it was soon suggested that it be cut through and thus eliminate the carry. An early trading post established at Apputuxet on the south bank between the present railroad and the Bourne bridges has been reproduced by the Bourne Historical Society and is well worth visiting.

In 1697 the project received official recognition when the General Court of Massachusetts ordered a committee to make an examination. Unfortunately there is no record of the report.

From then on many studies were made and reports submitted on a canal via its present general route.

THE CANAL

In 1899 the Legislature of Massachusetts granted a charter to the Boston, Cape Cod and New York Canal Company. Construction was begun in 1909 and the canal was opened to traffic of lighter draft vessels July 30, 1914, and completed in April, 1916, to project dimensions providing a canal 25 feet deep over a bottom width of 100 feet, widening to 300 feet at the east end and 250 feet at the west end and through the approach channel in Buzzards Bay.

The canal is eight miles long in the land cut and the dredged approaches are about five miles long in Buzzards Bay and one-half mile long in Cape Cod Bay. The eastern entrance, which is exposed to northeast storms, is protected by a breakwater. Last year the eastern half of the 100-foot section was widened to 170 feet, and a present contract provides for widening the western half to 170 feet.

The first cost of the canal is said to have been \$13,000,000. In 1919 a jury set its value at \$16,650,000. After twelve years of complicated and costly litigation the United States purchased the canal and all accessory facilities and real estate for \$11,500,000, and took charge on March 31, 1928, making it a toll-free waterway.

PRESENT BRIDGES *

The bridges built at the time the canal was dug are those now in use, and they are three in number, — two highway bridges and one railroad bridge. The most easterly is the Sagamore highway bridge, located about two miles from the eastern end of the canal. Near the western end, and about four and one-half miles from the Sagamore bridge, is the Bourne highway bridge. Both of these are two-span bascule bridges of the rolling support type, with clear widths between fenders of 140 feet. The distance from center to center of piers is 160 feet. The 140-foot width was adopted to permit a future widening of the canal without having to alter the bridges. This is rather amusing in the light of the actual widening contemplated today. The vertical clearance at the middle of each bridge is about 30 feet above mean high water. The third bridge is that of the railroad crossing close to the outlet into Buzzards Bay. It is a single-span, double-track hinged bascule bridge and carries the Provincetown and Woods Hole branches of the New Haven Railroad. It has the same clearance between fenders as the highway bridges, namely, 140 feet but the vertical clearance is only a few feet, the top of rail being 12 feet above mean sea level.

USE OF CANAL

The canal has been in operation since 1914, but in 1919 a progressive decline in its commerce began and continued as long as the Canal Company operated, in spite of the general increase in the coastwise traffic during the same period. Thus in 1919 about 2,900,000 tons of cargo were moved over the canal; in 1927 the figure had dropped to 900,000 tons. Between these years the total cargo tonnage of the Port of Boston increased more than 85 per cent and the coastwise tonnage increased 105 per cent. Since the abolition of tolls in 1928, when the United States took charge of the canal, the tonnage has increased considerably, but much of it comes from small vessels. The great bulk of the coastwise traffic still keeps to the outside routes. The cargo tonnage jumped to about 2,000,000 in 1928 and 1929 and has stayed around 2,500,000 since then until last year, when it increased to 2,800,000. However, about 9,000 ships of about 23,000,000 gross tons continue to use the outside route.

In its present condition the canal is capable of only a very limited use. Of the reasons why the canal has not attained a greater measure of success, the one which constitutes the principal objection of the major shipping interests is the risk to large vessels due to the rapid currents and

* See Fig. 8.

the narrowness of the prism. The average maximum daily current during neap tides is 3 feet per second and during spring tides is 7 feet per second. The second reason is the loss of time resulting from the canal being suitable for one-way traffic only, this also being due to the narrowness of the prism.

RECOMMENDED PROJECT

The report submitted in 1930 by the Corps of Engineers recommended a single lock 110 feet by 1,000 feet with 40 feet over the sill, a 30-foot channel 250 feet wide in the land cut and a new straight channel 400 feet wide and 30 feet deep through the Buzzards Bay approach. A single high-level, 6-lane highway bridge was to replace the two present highway bridges and a suitable railway crossing was to replace the present railroad bridge. The estimated cost was \$23,500,000. The project was favorably reported on by the rivers and harbors committee in 1932, but has not been included in a river and harbor bill as yet, the new work now in progress having been authorized as part of the Public Works Program under the National Industrial Recovery Act. The original recommendations of the chief of engineers have been modified so as to provide for two high-level, four-lane highway bridges, one at the village of Bourne and one at the village of Sagamore; for a vertical lift railroad bridge at the present location; and for an enlargement of the existing approach channel through Buzzards Bay to 500 feet by 30 feet in the straight reaches, and about 800 feet by 30 feet in the two bends. The land cut is to be widened to 250 feet by 30 feet, and tried out before the lock project is further developed. Early in 1933 the Department recommended the immediate appropriation of \$10,000,000 to cover the cost of construction in accordance with the above modifications.

THE NEW BRIDGES

This brings us to the part of the project of particular interest at this time,—the new bridges. With any enlargement of the canal, whether with a lock or as an open waterway, all three bridges must be replaced, since their spans are suited only for a 100-foot prism with provision for widening to 140 feet. The new bridges will have a horizontal clearance sufficient for a 500-foot canal. It was deemed best to provide for such an eventuality, because the cost was not unduly more than for a shorter span, and it is thought that after it is demonstrated that the 250-foot canal does not provide the first-class two-way waterway that the commerce seeking it deserves, the Department will decide

to widen it further before constructing locks, possibly up to 500 feet in width.

The decision to build high-level bridges was based on two considerations. A drawbridge over the canal with the currents as they are, and an expected 10 per cent increase for the 250-foot canal to 20 per cent increase for the 500-foot canal constitute a menace to navigation. With a failure or partial failure in the opening of the draw the possibility of a collision between the boat and the bridge is very real. With a following current this is almost a certainty. There are several cases on record of such accidents. Although no really serious accident has as yet occurred, the proved and ever present possibility of one is an unfavorable factor against the reputation of the canal with the shipping interests.

From the point of view of the highway traffic the drawbridges are hardly less objectionable. They must be opened several minutes in advance of the passing of the vessel, and although the delay to traffic is not of moment during the winter months, in the summer season, especially on week ends and holidays, the lines of accumulating cars frequently reach a mile on each side of the bridge. The recent records show that the summer daily average number of cars over each bridge is 5,000, with a Sunday average of 8,000. The record was 19,594 cars on the Bourne bridge on Sunday, July 3, 1933. The peak rate reaches 1,000 cars per hour. During 1933 the average number of openings during the summer months was 40 per day at about 5 minutes each, making a total of $3\frac{1}{3}$ hours open out of 24 hours.

Conditions will become worse with an enlarged canal. As the navigation increases, the spans would have to be opened more often and the greater the number of vessels passing, the greater would be the chance of accidents. As highway traffic increases, so will the blockades along the roads and the delays and dissatisfaction from having to wait for the bridge to close. The only remedy for traffic delays was to do away with the draw spans entirely and replace them with a high-level bridge or a tunnel. Estimates for a tunnel showed that the cost would be prohibitive. As the present highway bridges are only four and one-half miles apart, it was originally recommended that a single high-level bridge, located at about the center of the canal, be built. However, there was so much objection to this scheme that the project was modified to provide for two highway bridges.

As with the highway bridges, the railroad bridge at Buzzards Bay had to be replaced with either a wider draw span or with a high-level crossing elsewhere. Although the delays to trains from the opening of

the bridge are not of special importance, the number of times the bridge would have to be operated for the traffic of an enlarged canal would be considerably increased. However, it is not believed that railway traffic will increase to any considerable extent south of Buzzards Bay, and during the height of the summer season the train passings on the present bridge average only 44 per day. This, together with the fact that a high-level crossing for the railroad was prohibitive both in construction cost and in additional operating cost to the railroad, because of the long grades required, led to the decision for a vertical lift bridge. The lift span will be kept in the raised position except for the passing of trains, thus giving an unobstructed channel for vessel traffic for the greater portion of each day.

BRIDGE CLEARANCE

The vertical clearance originally recommended was 150 feet. Investigation showed that only 5 of the 180 vessels engaged in the coast-wise trade in and out of Boston have masts higher than 132 feet. The average height is about 100 feet. The masts of vessels of the type operated by the Luckenbach, Dollar and American-Hawaiian lines average about 120 feet. The number of vessels with 27-foot draft, or under, with masts over 130 feet is very limited. If the canal is made capable of passing vessels over 27-foot draft, the number of vessels denied passage would be about 18, operating in and out of Boston. It can be conservatively reasoned that by the time a canal would be constructed suitable for use by vessels drawing over 27 feet the trend toward telescoping masts will have become well established, and that no large carrier would hesitate to install telescoping masts if on frequent runs that would enable it to save from three to 10 hours' steaming time. It was therefore decided to use 135 feet clearance, which is the same as the Brooklyn bridge in the East River, New York.

PRESENT CONSTRUCTION

In September, 1933, \$4,600,000 was allotted from the N. R. A. appropriation for the construction of the three bridges. The contracts for design and supervision of construction had previously been let, and on notice of receipt of funds the engineers rushed the final plans to completion.

The P. J. Carlin Construction Company of New York was awarded the substructure contract for both highway bridges; and the Blakeslee,



FIG. 1. — HIGHWAY BRIDGE OVER CAPE COD CANAL AT BOURNE, MASS.

Rollins Corporation of Boston and C. W. Blakeslee & Son, Inc., of New Haven, in a joint bid, were awarded the substructure contract for the railroad bridge. Both started work December 18, 1933. Bids for the superstructures of the two highway bridges were opened January 3 and the work awarded January 6 to the American Bridge Company. Bids for the superstructure of the railroad bridge will be advertised by the end of January.

The engineers were requested to give careful consideration to esthetic values in their design. Cram & Ferguson of Boston assisted in the design of the highway bridges, and McKim, Mead & White of New York, of the railroad bridge.

The Bourne bridge will be the most beautiful in New England, and the shorter Sagamore bridge will be a close second. Although it is difficult to combine beauty with a vertical lift railroad bridge this one will surpass any other yet built in that respect.

THE NEW RAILWAY BRIDGE

The new railway bridge will be a vertical lift bridge with a movable span 544 feet long, the longest span of this type in the world. It will be a single-track bridge built parallel to, and 60 feet east of, the existing double-track bascule span, which carries the Woods Hole and Provincetown branches of the New Haven Railroad across the canal at Buzzards Bay near the western end of the canal.

The span will normally be kept in the raised position, providing 135 feet clearance beneath for vessels, about the same as the Brooklyn bridge, and will be lowered only for passing trains instead of being kept in the lowered position as is usual and raised for passing vessels. This requires that the design be based on a wind load of 30 pounds per square foot, instead of 15 pounds per square foot, in the raised position as has been customary heretofore (since it would be unusual to pass ships in a gale of more than 15 pounds per square foot).

The movable span weighs 2,000 tons and is raised by means of forty $2\frac{3}{8}$ -inch ropes at each end passing over four 15-foot diameter sheaves at the tops of the towers, and is counterbalanced by 1,000-ton concrete counterweights encased in steel. These main sheaves run in roller bearings in place of bronze bearings which reduce the friction 90 per cent and consequently the power required from 300 horse power at each end to 150 horse power. The storage battery unit now in use for the existing bascule bridge will be used for auxiliary power in case of breakdown of the main power lines.

Instead of placing the operating machinery in the center of the main span and raising and lowering the span by means of a rope drive, two power plants will be used, one in the top of each tower, which will be synchronized electrically to keep the span level in all positions. The synchronized electric motors will be direct connected to the main sheaves through gears, a recent development.

The main cable unbalance, due to the weight of main cables shifting from the movable span to the counterweights as the bridge is raised, which amounts to 15 tons at each end, will be compensated for by auxiliary counterweights with stainless steel cables running over sheaves at the top of the towers and connected with the movable span at the

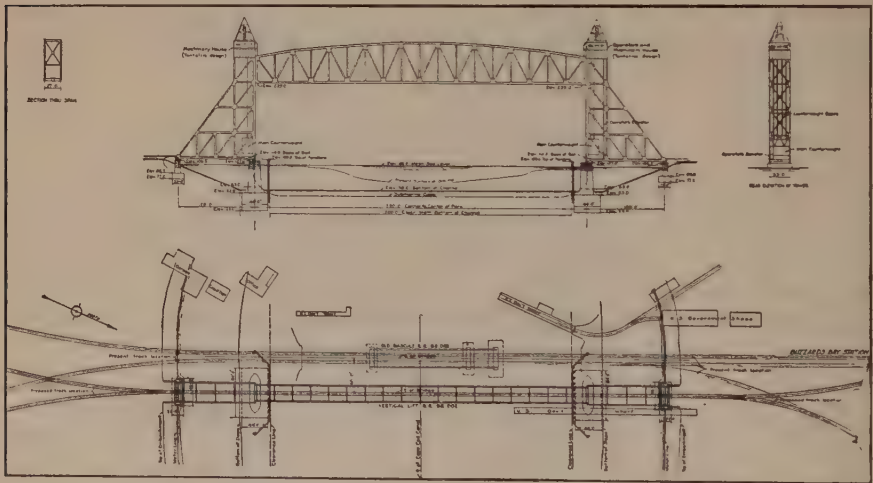


FIG. 2. — RAILWAY BRIDGE OVER CAPE COD CANAL

quarter points. Stainless steel is used to reduce visibility as these cables will not add to the appearance of the bridge, one of the important considerations in this locality. When in lowered position the movable span will have a positive moment (uncompensated weight) of 20,000 pounds. At times, due to sleet or snow, this will be increased to over 80,000 pounds.

The operator's house will be attached to the north tower about 30 feet above ground, and all switchboards, controls and contacts will be in a switchboard room close by, and easily accessible to the operator in case of arcing contacts or other trouble. The machinery room at

the top of each tower may be quickly reached by means of two elevators, one in each tower.

Considerable thought has been given to the appearance of this bridge, as lift bridges built in the past have been anything but attractive. As mentioned above, the use of stainless steel for the auxiliary counterweight ropes is a step in the right direction. Placing the machinery in the towers instead of in the middle of the span will be another big help. In addition, the top chord of the lift span has been given a graceful curve, and the bottom chord will be built on a flat vertical curve connecting an upgrade of about 1 per cent on each end of the bridge. The exact architectural design for the towers has not yet been definitely settled, but the latest design by McKim, Mead & White omits the diagonals at the shore ends of the span, places vertical members at the shore ends of the approach spans, and crowns the towers with open-work metal spires of attractive design.

DESIGN OF THE NEW HIGHWAY BRIDGES ACROSS CAPE COD CANAL

BY CARROLL A. FARWELL,* MEMBER

THE previous speaker has described the historical side of this project and has given the reasons for the choice of locations of the bridges. This brings us logically to consideration of the general design.

GENERAL DESIGN

The plans of the War Department provide for an ultimate widening of the canal to a bottom width of 500 feet, and although it will probably not be excavated to this width for some years, the bridges are to be constructed at this time to provide for this future width. A vertical clearance above high water of about 135 feet was specified, this being fixed by the desire to provide the same clearance here as in Long Island Sound and the East River, where Brooklyn bridge now fixes the overhead clearance at this figure. The bridges in each case cross the canal substantially at right angles to its center line, and there was therefore no question of skew spans.

The requirement for vertical clearance results in locating the roadways of the bridges over the canal at an elevation about 150 feet above

* Member of firm of Fay, Spofford & Thorndike, 44 School Street, Boston, Mass.

mean sea level. This is much higher than any surrounding land, and in order to make the bridges as short as possible it was necessary, in general, to use the maximum gradient on the side spans. The limiting gradient chosen was 6 per cent, that being considered the feasible maximum for the heavy traffic to which these structures will be subjected, particularly during the summer season. The rising gradients approaching each bridge are connected by 700-foot vertical curves.

A roadway width of 40 feet between curbs was decided upon, providing for four lanes of traffic, two lanes in each direction. Foot travel across the bridges will be small in amount, so that a sidewalk at one side

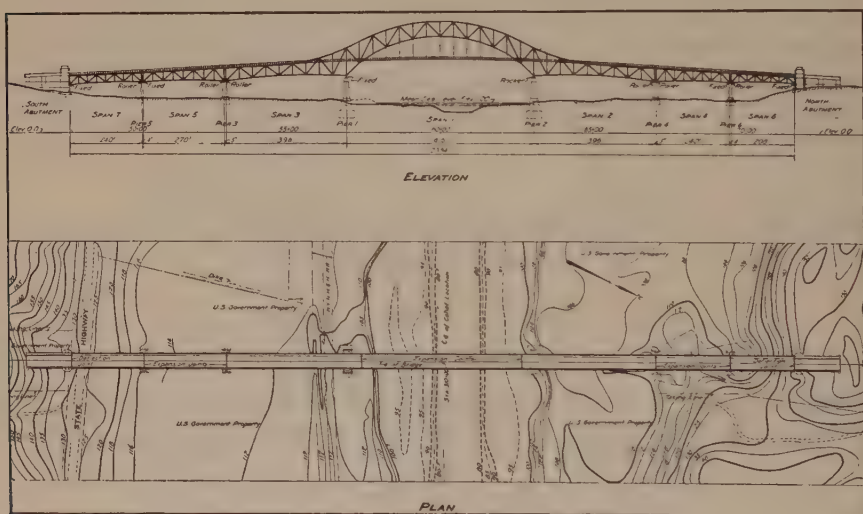


FIG. 3. — PLAN AND ELEVATION OF HIGHWAY BRIDGE AT SAGAMORE

only is provided, that at the Sagamore bridge being on the easterly side, and that at the Bourne bridge on the westerly side.

For economy, it was, of course, desirable to make the two bridges as nearly similar as possible. The three spans of the Sagamore bridge are the same in most respects as the three central spans of the Bourne bridge, there being a slight difference in elevation due to the difference in high-water and low-water levels in the canal at the two sites, and the spans are reversed at one bridge from their position in the other to provide sidewalks on opposite sides of the center lines. The main channel piers are closely similar in the two bridges, the differences being due to the difference in elevations of water levels in the canal.

All feasible types of structure were considered, but the type of superstructure adopted — a three-span continuous structure for the central spans, with simple approach spans in the case of the Bourne bridge — proved most desirable.

The War Department desired that the bridges should be pleasing in appearance, and in order to insure thorough architectural consideration, the firm of Cram & Ferguson of Boston was retained as consulting architects. They found that the lines of the structure as laid out from an engineering viewpoint needed little modification to produce a pleasing outline. The piers are proportioned to give the desirable assurance

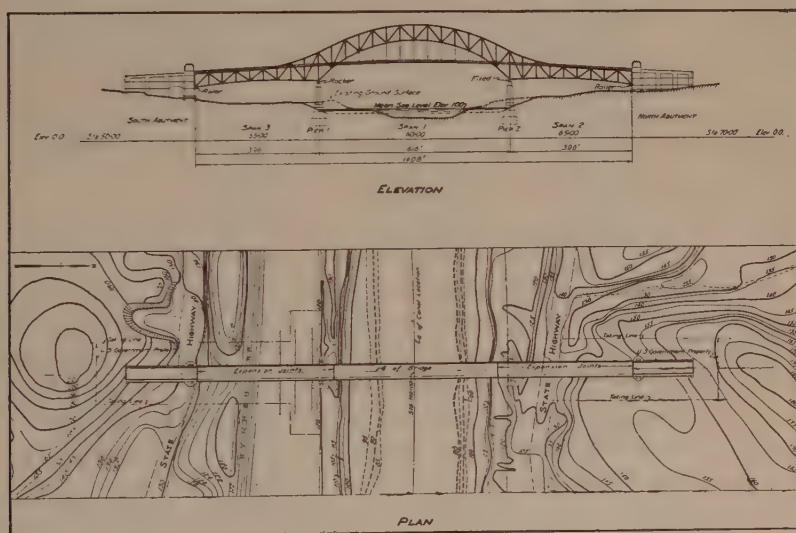


FIG. 4. — PLAN AND ELEVATION OF HIGHWAY BRIDGE AT BOURNE

of stability, and the abutments are designed to form substantial looking buttresses at the ends of the steel work.

BORINGS

Only a limited amount of data of underground conditions was available from the construction of the existing bridges over the canal and from a few borings which had been taken. As soon as the approximate locations of piers and abutments were known, borings were started in order that the best information possible would be available for design and for estimates of cost. A total of 26 borings were made at the

site of the Bourne bridge and 18 at the Sagamore bridge, exclusive of several borings carried only to partial depth because of boulders encountered. At each channel pier at least two borings were made to a depth of about 120 feet, or about 50 feet below the bottom of the pier, in order that the nature of the soil which must carry the load would be known. At the abutments and at the smaller piers of the Bourne bridge the borings were in general carried to a depth of about 50 feet, the bottoms of these foundations being about 15 feet below the natural surface.

As would be expected from the geology of the region the material encountered was largely sand, with no regular stratification and of varying grain sizes, with some gravel. At some points clay was found mixed with the sand, but in no instance was clay found alone. Boulders were encountered at several borings, and from this, as well as from information from excavations made for the existing bridges and for the canal prism itself, it is expected that boulders of varying sizes and in varying amounts will be found in the pier excavations.

FOUNDATIONS — GENERAL

The loads from the superstructure are, of course, largely vertical under all conditions, and when combined with the dead load of the foundation result in a condition of loading of the soil at the base of the foundation which is relatively simple. Consideration was given not only to the vertical live and dead loads, but also to the wind load and the forces longitudinally of the bridge resulting from friction in the roller nests, on which the superstructure moves as it expands and contracts, and resulting from traction or braking effect of vehicles on the roadway. This last was felt to be very theoretical, but its consideration was required in the specifications under which the design was made. In addition to these, consideration was also given to the eccentricity of loading which would result from inaccuracy of location of the pier bases. It was recognized that by whatever method the piers were constructed, a certain tolerance in location was necessary, and this was considered in the design.

In principle, the foundations are spread footings resting directly on the soil with loadings varying from an average of about 3.6 tons per square foot with variations of about 1 ton per square foot, plus or minus, at the channel piers to an average of about 2 tons per square foot in portions of the abutments. Probably no combination of forces will cause a load on the soil beneath a channel pier in excess of 4 tons per square foot at any point.

CHANNEL PIERS

Each channel pier consists of two columns, one under each truss, — making them 51 feet on centers, — with a connecting diaphragm at the top, and supported on a common base. The exterior dimensions of the columns are governed by the areas of the base plates at their tops carrying the steel, the batter being such as to produce a pleasing appearance. These requirements resulted in a column larger than needed for strength,

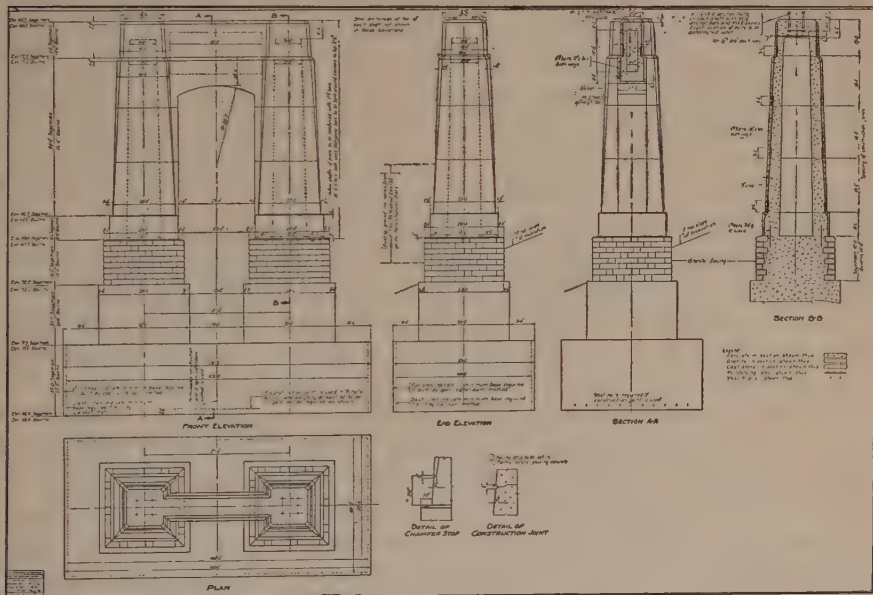


FIG. 5. — MAIN CHANNEL PIERS OF HIGHWAY BRIDGES

and, as weight is important, the columns, as well as the connecting diaphragm, are hollow. There would be little gained in weight by omission of the concrete below water line, so the hollows in the columns are stopped just above high-water line.

From a few feet above extreme high water to a few feet below extreme low water the columns are faced with granite.

The channel piers are located 616 feet on centers, such that in the ultimate 500-foot canal the side slopes of the canal will intersect their ends at about mean sea level and the exposed portions of the piers will provide a minimum clearance in the waterway of 588 feet. As a part

of the work of construction of the bridges, the final slopes of the canal are to be excavated in the immediate vicinity of the channel piers.

The elevation of the bases of the channel piers was fixed about 50 feet below mean low water, placing them 10 feet below the adjacent canal bottom if and when the canal is dredged to the possible extreme depth of 40 feet at mean low water. The elevations of the tops of the bases are such that after the concrete is placed, the pier area can be pumped out without danger of flotation.

The specifications were so written that the piers could be excavated and the base concrete placed either by use of the cofferdam method or by use of the caisson method, the placing of the concrete of the base under water being permitted in either method. Under the cofferdam method, the bases must have average dimensions not less than 50 feet by 108 feet, and are to be so located that the center lines are within 1 foot of correct position. Under the caisson method this tolerance in location of center lines was reduced to 6 inches, as it was felt that caissons could be more accurately sunk, and also that, in case they were out of position, compressed air could be applied to the necessary pockets in the caisson, thus permitting the excavation for the base to be enlarged or deepened as necessary. With this lessened tolerance the base under the caisson method is made 2 feet smaller in each horizontal dimension. The contractor for the work has elected to use the cofferdam method.

It was considered advisable to specify that the base concrete — poured under water — should be placed in one operation from bottom to top in order to avoid the formation of horizontal joints and laitance. If concrete is poured over the entire area of the base this will involve, under the assumption that a layer 2 feet thick must be placed on the underlying surface in not more than two hours, the placing of 200 cubic yards of concrete per hour for twenty-five hours. Believing that this might involve too large a concrete plant layout, provision is made for concreting the bases in two parts by permitting construction joints in each case in a vertical plane at the center with tension reinforcement near the bottom.

The use of structural steel towers in place of the upper portions of the concrete piers was considered but did not prove feasible.

SMALLER PIERS

The four piers between the channel piers and the abutments of the Bourne bridge are similar to the channel piers and introduced no particular problems. The columns are not of sufficient size to warrant making them hollow, and, of course, no granite facing is needed. Moreover, it was

necessary in these piers to reinforce the base at the top against negative moment, as its thickness — 13 feet — is about half the clear distance between the columns.

ABUTMENTS

The four abutments of the two bridges are similar except that at the south end of the Sagamore bridge provision is made for the passage of the existing low-level highway through the abutment. The construction is essentially a reinforced concrete viaduct with curtain walls at the sides.

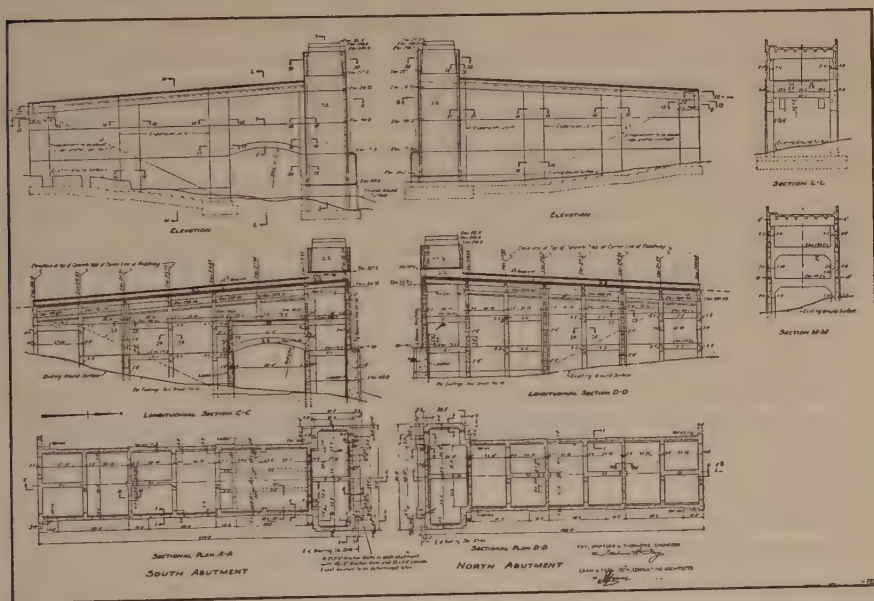


FIG. 6. — ABUTMENT ELEVATIONS AND SECTIONS OF HIGHWAY BRIDGE AT SAGAMORE

Expansion joints masked by pilasters are provided at intervals, and the portion of each abutment adjacent to the steel work is enlarged to form pylons at each side extending above the roadway. Solid concrete balustrades with granite copings are provided throughout the length of each abutment. At the canal end of each abutment a bridge seat is provided to receive the structural steel, and in this portion the structure is necessarily of heavier construction.

The back end of each abutment is open to permit the approach fill to slope down inside the walls as on the outside, avoiding the necessity of designing the side walls as retaining walls.

TREATMENT OF CONCRETE SURFACES

Throughout both bridges all exposed concrete surfaces are designed to be left substantially in the condition they are when the forms are stripped. Horizontal construction joints are definitely located, and provisions are made to insure straight and horizontal lines on the exposed surfaces.

Two types of surface are called for, — one, a smooth surface on the pylons of the abutments and in certain other areas, is to be formed by the use of steel plates or of other very smooth forms which will produce similar results; and the other, a less smooth surface for which it is required that lagging of uniform width of not less than 5 nor more than 8 inches, or of random widths within these limits, shall be used, the lagging to be truly horizontal, and all horizontal joints between laggings to be carried continuously across the full width of the particular plane surface under construction. The face of the lagging against the concrete is to be unplanned. After removal of forms all exposed surfaces are to be rubbed with carborundum brick and water, but no grout or mortar is to be used.

STEEL SUPERSTRUCTURE

In designing the bridge the specifications of the American Association of State Highway Officials have been used, as these are also the standards of the Federal Bureau of Public Roads, the loading being that known as H-20, as follows:

For main truss members, a uniform live load on the roadway of 525 pounds per linear foot for each of four traffic lanes, each lane considered as having a width of 9 feet; also, concentrated loads at the center of each traffic lane of 14,800 pounds for moment and 21,400 pounds for shear, these loads being located along the length of the bridge in such a position as to give the maximum stress in any bar under consideration; and, in addition, a uniform live load on the sidewalk as given by the following formula:

$$P = 40 + \frac{3,000}{L}$$

in which

P = live load in pounds per square foot of sidewalk area but not to exceed 100 pounds per square foot.

L = loaded length of sidewalk in feet necessary to give maximum stress in member under consideration.

For floor system, floor suspenders and secondary truss members, one 20-ton truck followed by one 15-ton truck on each or any traffic lane. The dimensions and load distribution are as follows:

Axle spacing, 14 feet.

Wheel spacing, 6 feet.

Total width for clearance, 9 feet.

Trucks spaced, 44 feet between centers.

Minimum distance of center of wheel from inside face of curb, 18 inches.

Load on each rear wheel four-tenths of total load. Load on each front wheel one-tenth of total load.

Sidewalk load 100 pounds per square foot.

Proper provision is made for impact.

It was found to be economical to use silicon steel with the usual increase of 35 per cent in allowable unit stress in place of carbon steel for the greater portion of the main truss members of the structures, as well as the stringer beams in the long panels of the three central spans and the floor beam flanges of all spans. The unit stresses used are those given in the previously mentioned specifications, with the further limitation that the unit stress resulting from the application of the live loads combined with the dead loads and impact shall be, in no case, in excess of three-fourths of the 24,000 pound unit stress for dead load and for the combination of dead plus double live and impact given in the aforementioned specifications.

As a considerable portion of the bridge is a "through" structure the trusses of the central spans necessarily are placed outside the deck, making them 51 feet on centers. It was not found desirable to decrease this spacing for the smaller spans of the Bourne bridge, and the trusses of these spans are also at the same distance on centers. In order to provide the clearance necessary near the ends of the channel span it was desirable to incline the chords upward at a considerable angle at the channel piers. This resulted in carrying the trusses to a considerable height above the roadway in the greater portion of the channel span; in fact, the highest steel is about 125 feet above the roadway. As the truss is 50 feet deep at this point the roadway is about 70 feet below the bottom chord of the truss. Throughout this portion of the bridge the deck is hung from the trusses by wire rope suspenders, two at each end of each floor beam.

There are expansion joints over the supports at each end of the central three-span structure, and also at the other small piers of the

Bourne bridge where the steel work is supported on roller bearings. In addition, there are minor expansion joints at each end of the suspended portion of the roadway in the center span in order to make the floor system discontinuous at these points. At Sagamore bridge the end expansion joints are at the abutments. In the Bourne bridge deflection joints in the roadway slab are also provided at the abutments to insure that this slab is not stressed because of truss deflections.

As regards erection, the central or channel span will in each case be erected by cantilever methods. This is the logical method for this type of structure, and, moreover, the canal must not be obstructed. After erection of the two cantilever arms, closure is made at the center by jacking at the shore ends of the flanking spans, which jacking is continued as necessary to produce the required reaction at these points.

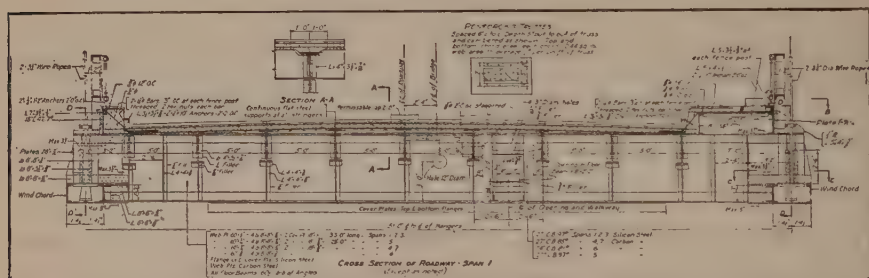


FIG. 7. — DECK SECTION OF HIGHWAY BRIDGES

FLOOR AND APPURTENANCES

The floor system consists of steel floor beams at each panel point, the panel length varying from 44 feet in the central spans to 30 feet in the side spans at Bourne bridge. The floor beams carry steel I-beam stringers, the stringer spacing being 5 feet. On the stringers is to be cast a concrete slab floor 7 inches thick of light-weight concrete, secured by the use of aggregate of burned clay or shale, reinforced with reinforcing steel trusses having an over-all depth of 5 inches and spaced 6 inches on centers. Traffic markers of white concrete are to be placed to indicate the traffic lanes, and between these the concrete deck is waterproofed and surfaced with bituminous macadam. At each side of the 40-foot roadway traffic is protected by a two-step curb 16 inches in height, the lower step having a steel wearing strip. The sidewalk has a clear width of about 6 feet, and on the other side of the roadway a space of about 18 inches between the curb and the railing insures that the railing be clear of all overhanging truck bodies.

The railings are somewhat similar to the "Boston type" railing, but with some variations. The railings are not uniformly spaced, but are in pairs for architectural reasons. Instead of the cast-iron posts of the typical Boston type railing, the railings on these bridges will be supported by structural steel posts with channel iron braces, the posts being attached to the structural frame of the bridge itself. Ducts to carry the lighting cables are provided in the concrete of the sidewalk slab or in the top of the opposite curb.

In order to provide access to the underside of the roadway for inspection, for installing pipes or cables of public utilities, and to facilitate painting, a walkway is provided the entire length of each structure close under the floor above the bottoms of the floor beams, there being openings for passage through the webs of the floor beams. Alongside of these walkways holes are provided through the webs of the floor beams for electric cables and for a gas pipe. It is not known that any public utility company is planning to use the structures at the present time, but it seems probable that they will be so used in the future.

LIGHTING

Decision has been made to provide roadway lighting for the two structures, and although plans for this feature are still somewhat tentative, it seems probable that lights will be provided — one on each side of the roadway — at intervals of approximately 200 feet. Lamp-posts are to be of structural steel in keeping with the steel superstructure itself. Standard street lighting equipment will be used for the fixtures.

In addition to the roadway lighting, it will be necessary to provide navigation lights in the channel spans, and it seems desirable to place a light on the highest part of each structure as a safeguard to air navigation.

CONSTRUCTION ARRANGEMENTS (LIGHTS)

As the two bridges are so closely similar, both in their superstructures and their substructures, it was felt that dividing the work between the two structures would substantially increase the cost. On the other hand, it was believed that a division of the work between the substructures of both bridges as one part and the superstructures of both bridges as the other part was entirely logical, as were these parts combined in one contract one portion or the other would undoubtedly be sublet by the successful bidder. The work therefore was divided into these two parts for construction purposes, one covering the substructures of both bridges, including the abutments (except for the roadway surfacing),

and the other covering the steel superstructures, the deck construction between abutments, and the roadway surfacing throughout both bridges. This arrangement also permitted the engineers to have a little more time for the preparation of the contract plans for the superstructures — an important consideration under the time schedule laid down for the work. A third and very minor contract covering the lighting facilities has yet to be made.

In the receipt of bids and in contracting for the work the endeavor was made to define very closely the work to be done, and having done this, bids for the substructure were received on the basis of three items, two of which were merely to cover additional concrete in the foundations of piers and abutments if unforeseen conditions should require enlargement over the dimensions shown on the contract plans. In the case of the superstructure, bids were received and a contract is to be made on the basis of four items of which only three are of importance, — carbon steel on a pound basis, silicon steel on a pound basis, and the bridge flooring, including all concrete, railings, surfacing, etc., on a lump sum basis.

The P. J. Carlin Construction Company of New York City were the low bidders on the substructure work, and the contract has been signed with them and work is under way at the site. The American Bridge Company were the low bidders on the superstructure.

Costs. — The low bids on the work, using the estimated quantities, were as follows:

Substructure	\$1,337,700 00
Superstructure	1,444,730 00
	\$2,782,430 00
Allowance for lighting, contingencies, etc.	42,570 00
Total contract cost (approximate)	\$2,825,000 00

It may be of interest in this connection that the price bid on the carbon steel was 4.72 cents per pound, and on the silicon steel, 5.33 cents per pound. The carbon steel includes the wire rope suspenders, miscellaneous castings, etc.

Time Schedule. — The formal contract with the engineers was not executed until September 11, 1933, but, to be perfectly frank, this action was anticipated, and the engineering work was started some two weeks or more before that time. Preliminary plans were approved about

September 26, contract drawings and specifications for the substructures were submitted to the district engineer on October 30, and bids from contractors were received on November 20. The contractor to whom the work was awarded was definitely ordered to proceed on December 8. The contract drawings and specifications for the superstructures were submitted on December 7, bids were received on January 3, 1934.

Similarly the contractors are expected to conform to a rigid time schedule, it being required by the specifications that those portions of the abutments which support the steel superstructure shall be completed within four months after date of notice to proceed, the intermediate piers of Bourne bridge within five months, the main channel piers for both bridges within six months, and the entire work of the substructure contract within eight months, or on August 8, 1934, unless an extension of time sets the date of completion ahead. The superstructure specifications require that the work of the superstructure contract shall be completed within 320 calendar days (approximately ten and one-half months) after date of notice to proceed, and it is also provided that under certain conditions this time may be extended if the various portions of the substructures are not completed as planned. The foregoing schedule calls for completion of the entire work about December 15, 1934, and the meeting of this date in the very early winter was considered to be an important matter because, if the concrete of the floor and the bituminous surfacing are not placed before this time, it is doubtful if they could be placed for perhaps three months, delaying the completion of the bridges until the early summer of 1935, and making a break in the construction operations which would be expensive for all parties concerned.

PRESENT STATUS OF WORK

At the present time the substructure contractor has cleared a large portion of the right-of-way in preparation for his operations, and is setting up derricks at three of the four channel piers. Excavation is under way at all four channel piers and at one of the smaller piers. It is expected that a beginning will be made on one of the channel pier cofferdams soon.

APPROACHES TO NEW HIGHWAY BRIDGES OVER CAPE COD CANAL

BY FRANK V. ANDREWS *

WHEN the Federal government decided to build two high-level bridges over the canal, the Massachusetts highway engineers were requested to assist in determining the feasibility of connecting the existing highways with the proposed bridge sites, and to handle the design and engineering on these approaches. Plans showing the topography along the banks of the canal were made available and the United States Corps of Engineers and Fay, Spofford & Thorndike, the consulting engineers on the bridges, rendered hearty co-operation.

These new bridges are to replace the existing low-level bridges at Bourne and Sagamore, but not in the same locations, new sites being necessary to provide high ground at the ends of the bridges and to reduce the length and cost of the bridge structures. These bridges will have to take care of all vehicular traffic to and from Cape Cod. Some idea of the amount of traffic to be expected may be gained from records of traffic counts taken last year on the existing bridges:

	Average Week Day (Number of Vehicles)	Average Sunday (Number of Vehicles)	Heaviest Sunday (Number of Vehicles)
Bourne bridge	9,500	11,000	19,600
Sagamore bridge	6,000	9,000	10,000
Totals	15,500	20,000	29,600

The total of the count taken on the day of the eclipse, in 1932, approximated 40,000 cars.

The existing highways to be connected with the bridges on the north side of the canal are, first, the road from Plymouth and Boston, Route 3; second, the road along the canal between the bridges, which is 150 feet back from the canal bank at the Sagamore bridge, and 1,300 feet back at the Bourne bridge; third, the road coming through Buzzards Bay village, carrying Route 6 from New Bedford and the West, and Route 28 from Middleborough and Boston. Route 28 traffic

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would cross the Bourne bridge, as would part of Route 6 traffic, but some of Route 6 traffic would continue up the north side of the canal to the Sagamore bridge.

The existing highways to be connected on the south side of the canal are, first, the road along the canal between the bridges, which is 800 feet back from the canal bank at the Bourne bridge, and 500 feet back at the Sagamore bridge; second, the main approach from the north side of Cape Cod, Route 6; third, the main approach from the south side of Cape Cod, Route 28, coming through Falmouth. The studies having established the feasibility of making these connections, the bridge designs were worked out sufficiently to determine the position and grade of the ends of each bridge, and we proceeded to develop the approaches. The ends of the bridges were from 70 feet to 100 feet above the existing highways which extend along each side of the canal. On both sides of the Sagamore bridge, and on the south side of the Bourne bridge, the bridge structures will pass over these lower highways, making them natural underpasses. On the north side of the Bourne bridge, however, the bridge structure ends 300 feet before it reaches the highway, and is about 65 feet above it in elevation. In every case it is necessary to pass over these existing highways and swing back to meet them at grade.

The country is very rough and heavily wooded. It was necessary to complete the surveys and plans close to the bridges at an early date so that layouts and land takings could be made before the bridge contracts could be let. A great deal of time was saved by having the field notes photostated each night and delivered to the draftsmen the next day.

The problem was to design the approaches economically, but with a view of handling a large volume of traffic without annoying delays or congestion, eliminating left turns or the crossing of traffic in so far as possible. With this in mind, traffic circles were planned for those points on the approaches where traffic movements were varied and tended to cross one another. Traffic circles allow a steady flow of traffic, afford safety to traffic all in one direction, and prevent the bunching of cars with the subsequent danger when separating into their natural speed classes.

The main approaches were planned as 40-foot or four-lane, roadways of bituminous macadam with a gravel sidewalk on one side. The circles, 300 feet inside diameter, will have a 48-foot surfaced roadway. The grades will not exceed 6 per cent, and will be connected with easy vertical curves at changes of grade and entrances to other roads.

On the south side of the Bourne bridge the road descends from the end of the bridge on about 4 per cent grade for 350 feet to a traffic circle.

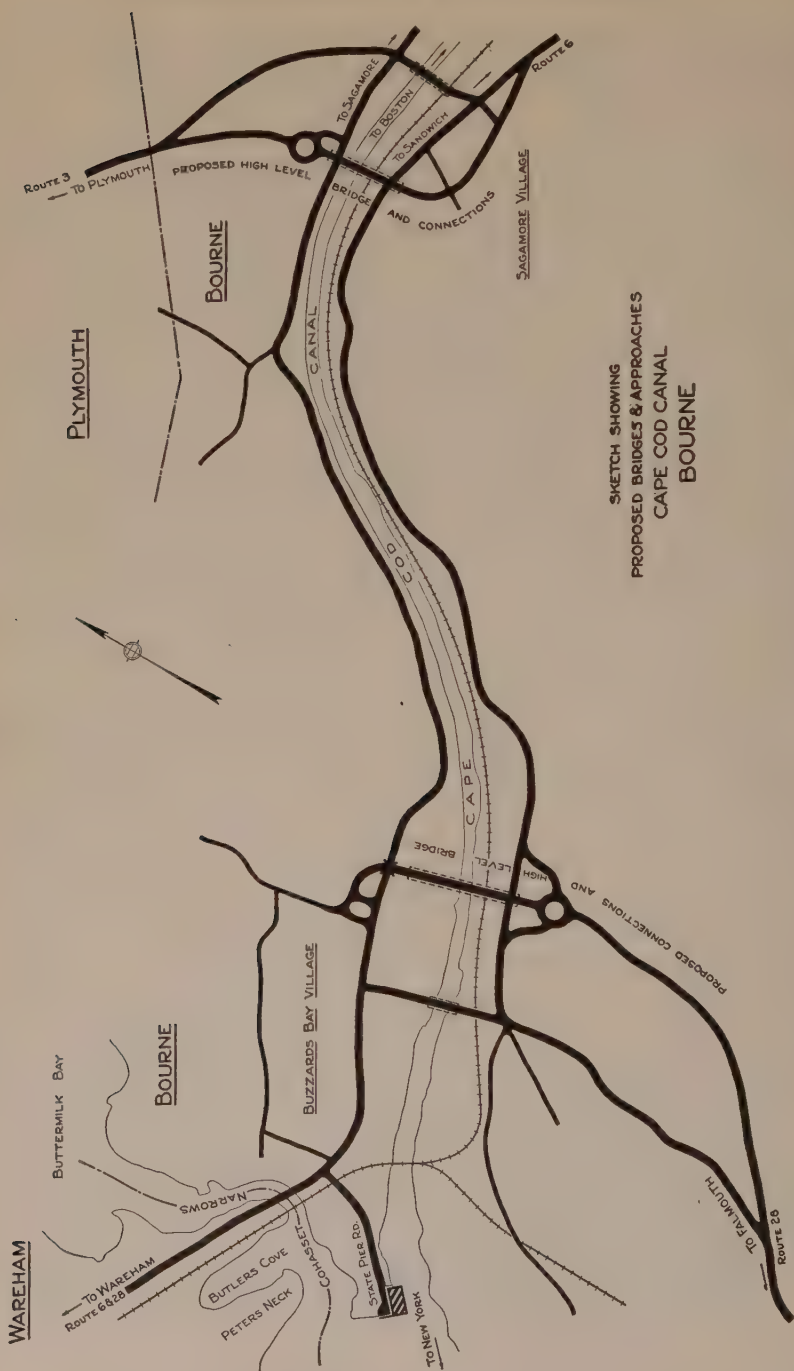


FIG. 8. --- NEW HIGHWAY BRIDGES AND CONNECTIONS TO EXISTING HIGHWAYS

From the westerly side of this circle a road will lead down to the existing highway, a distance of 1,000 feet, with 800 feet of it on 6 per cent grade. This ramp will serve local traffic principally. Directly opposite the bridge entrance, or on the south side of the circle, a road will lead off for the Falmouth road, 6,500 feet away. This will be part of Route 28. From the easterly side of the circle, a road will lead down to the existing highway; its length will be about 1,000 feet with about 800 feet of it on 6 per cent grade. This ramp will carry local traffic and part of Route 6 traffic.

On the north end of the Bourne bridge the structure will end before reaching the existing road. The approach will be carried over the existing road. To construct a circle directly on line with the bridge would bring it on a fill of more than 30 feet, making it dangerous for traffic turning on a short radius, expensive to build, and a permanent eyesore. After trying many schemes, the new road was swung away from the bridge on about a 1,000-foot radius, dropping on a 6 per cent grade for about 800 feet, and extended 2,000 feet to a point where the circle will take care of a local road intersection as well as main line traffic. The conditions here are favorable. The circle will be inexpensive to build, and all roads will enter it on fairly level grades.

From this circle the roads will radiate to the bridge, to a local road, to a driveway, to main Routes 6 and 28 combined, and to the existing road along the north side of the canal, which will pass under the main approach to the bridge.

The north approach to the Sagamore bridge extends from a point on the Plymouth-Boston road, Route 3, leaving near the Bourne-Plymouth line, and running 8,000 feet to a traffic circle. This road will be surfaced 30 feet wide. From the circle a 40-foot surfaced road will run to the bridge 600 feet away, 300 feet of which will be 6 per cent grade. From the easterly side of this circle a ramp will curve out and then run parallel to the bridge, 300 feet east of it, and come down to the existing road along the north side of the canal. This ramp will be 1,300 feet long and on about 5 per cent grade. The existing road along the canal will pass under the bridge structure, 100 feet below it. Only one house will have to be moved in building this ramp.

On the south side of the canal the existing highway, slightly relocated, will pass through a concrete archway in the Sagamore bridge structure, 80 feet below the bridge roadway. The main approach will continue from the south end of the bridge on a 6 per cent grade for 600 feet, then on very easy grades for 4,000 feet to join the existing highway, Route 6, near the easterly end of Sagamore Village, to carry traffic down the north side

of Cape Cod. A local connection will be made at the center of Sagamore Village, between the main approach and the existing highway. Then again at a point near the westerly end of Sagamore Village, about 1,000 feet east of Sagamore bridge, an existing town road connects the main approach to the existing highway. This last connection will serve traffic coming under the Sagamore bridge from the West.

A traffic circle is not needed on this approach under present conditions, as the traffic making left turns will be small. It is in a thickly settled section where speed should be controlled, and traffic can enter or leave the main approach only from the north side. The land damage is high on this approach and six houses will have to be moved to make room for construction.

The soil over the entire project is sandy so that slopes will be made 2 to 1. There are three short bogs to be crossed. The peat in one of them is 24 feet deep. Most of the land taken is low-grade woodland.

While the earth quantities on the project are large, the unit price should be low, as the excavation is easy to handle, and borrow is available close by.

The cost of construction of all approaches is estimated to be \$700,000.

CAPE COD CANAL PIER

BY FRANCIS L. SELLEW *

THE construction of a pier at the Cape Cod Canal by the Massachusetts Department of Public Works was authorized by the General Court under the provisions of chapter 441 of the Acts of 1931. This act appropriated \$250,000 for the work and provided in part that the location must be approved by the United States War Department before any expenditure could be made. In order that the department might secure the views of local residents as to the most advantageous location for the pier, a hearing was held in the Bourne town hall on June 26, 1931. At this hearing several locations were suggested and arguments heard for and against all locations. After the hearing the Public Works Commissioners viewed the locations and decided that there was probably only one location where approval of the project might be expected on the part of the United States War Department, and this location was at the Buzzards Bay end of the canal.

Tentative plans were prepared covering the construction of a quay

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wharf about 1,000 feet in length located on the northerly side of the canal, about one-half mile westerly of the railroad bridge and about 100 feet northerly of the side line of the canal location. This project included the dredging of the area between the face of the wharf and the canal to a depth of 25 feet at mean low water. A petition requesting a permit from the War Department for this construction was refused after a hearing, on the grounds that vessels using the pier could not turn in the basin in front of the same without interfering with traffic in the canal, and, further, the tidal current was such that vessels could not be readily handled. The army engineers stated that they would approve this general type of construction if the pier were set back 400 feet from the canal, but the cost of additional dredging with this setback was so great that the work could not be performed with the appropriation of \$250,000 available for the work.

Further studies were then made to find a location and type of construction which would eliminate the objections raised by the War Department, and plans of the pier as finally constructed were submitted to the War Department and a permit granted.

The location finally adopted and approved was only slightly farther west than the earlier location, which was rejected, but the new location provided for a turning basin in Buzzards Bay at the westerly end of the pier and extending about 600 feet northerly from the canal. This turning basin eliminated the necessity for vessels entering the canal prism to turn, as the construction permitted lines being kept on the vessel until it was headed in the direction desired.

The main pier is a quay wharf of solid fill construction about 600 feet in length and 75 feet wide; the face of the pier sets back 100 feet from the northerly side line of the canal taking. At the westerly end of the pier, and extending northerly about 500 feet along the side of the turning basin, and at right angles to the main pier, a catwalk has been constructed of creosoted timber, and along the edge of this walk mooring posts have been provided with riding pile clusters outside the same, so that vessels may either tie up alongside the catwalk, or it may be used for attaching lines when a large vessel is leaving the pier and desires to turn.

The wall along the face of the main pier is supported by a relieving platform of reinforced concrete carried on spruce piles which are cut off at low water. The face of the pier below low water is constructed of interlocking steel sheet piling of high arch section weighing about 32 pounds per square foot. The sections of steel piling are about 47 feet long and have been driven so that the bottom of the steel sheet piling is 45 feet

below mean low water. The sheet piling is anchored back to a reinforced concrete wall, located about 60 feet back of the face of the wharf, with 2-inch round steel rods spaced 8 feet apart. The upper wall is concrete of gravity section, the face being covered with 6-inch creosoted timber up to a point above extreme high water. This timber is anchored into the concrete with galvanized iron bolts. The wall is anchored to the relieving platform by turning up reinforcing rods in the platform.

Along the face of the pier oak fender piles are spaced about 6 feet apart and capped with a 12-inch by 14-inch yellow pine timber, creosoted. Heavy pile clusters sheathed with oak on the outer face provide chaffing fenders for large craft. These pile clusters are anchored to the pier with galvanized iron chains.

The central portion of the pier for a distance of about 220 feet is constructed 2 feet higher than the balance of the pier, and on this high section a one-story freight shed 220 feet long and 35 feet wide has been constructed setting back 20 feet from the face of the pier. The side walls of the building are of concrete and brick with a plank and slate roof carried on steel trusses. Three large doors 10 feet wide and 14 feet high have been provided on each side and one in the westerly end for handling freight. The easterly end of the building is partitioned off to provide toilets, heating plant, a small office and waiting room. The floor of the raised portion of the pier is paved with a reinforced concrete slab. The loading platform on the northerly side of the building is at the level of a truck body to provide easy loading, and trucks may be driven into the shed or along the wharf between the side of the pier and the shed by using ramps provided at the ends of the shed. Two movable cargo drops have been constructed on the face of the pier at the shed to facilitate handling freight and to provide means for automobiles or trucks to be taken on or off of vessels using the pier.

The depth of water in the berth along the face of the pier is 25 feet at mean low water, and construction was carried out so that this depth might later be increased to 30 feet at mean low water if desired. The depth of water in the turning basin is 23 feet at mean low water, which is probably the present prevailing depth in the Cape Cod Canal.

The main pier was constructed and dredging performed under contract with Merritt-Chapman & Scott Corporation, and the building was constructed under contract with the Durso Construction Company.

The cost of the work was divided about as follows: pier proper, \$145,000; dredging, \$78,000; building, \$25,000. An additional appropriation of \$12,500 was made in 1933 to complete the building, making total expenditure, including engineering costs, \$262,500.

THE NEWTON HIGH-LEVEL SEWER

BY ARTHUR L. SHAW,* MEMBER

(Presented at a meeting of the Sanitary Section of the Boston Society of Civil Engineers, March 7, 1934)

HISTORICAL

THE topography of Newton is such that all but a small area in the southerly section drains toward the Charles River. Therefore, when a general plan of sewerage was adopted for the city, it naturally provided for the construction of main sewers sloping in a generally northerly direction toward the river. These sewers were designed on the separate system and are connected with the metropolitan Charles River Valley sewer, which was completed in 1892 and was designed for conditions anticipated in the year 1930. It serves Waltham, Newton, Watertown, Brighton and parts of Brookline and Back Bay. Until 1904 it discharged through the old Boston main drainage system into Boston Harbor at Moon Island.

The Newton high-level sewer is a link in the chain of main sewers which serve Greater Boston. It is an extension which was anticipated in 1899 when a plan was adopted for the relief of the Charles and Neponset River valleys by means of a metropolitan high-level sewer from Peddock's Island (later changed to terminate at Nut Island) to the Brighton-Newton line. The metropolitan high-level sewer was intended to intercept the sewage from as large a high-level area as possible, and to discharge this sewage by gravity, together with sewage pumped from certain lower areas, at a suitable point in Boston Harbor.

In 1904 the high-level sewer was completed from Nut Island to the Ward Street Pumping Station, and the contents of the Charles River Valley sewer were then pumped into the new sewer. Between 1907 and 1909 the high-level sewer was extended to Oak Square, Brighton.

Prior to 1930, the design date of the metropolitan Charles River Valley sewer, it became evident that this sewer was at times seriously overloaded. Certain of the main sewers of Newton were also sometimes overtaxed, particularly in the lower reaches. The need for relief was clearly indicated.

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In 1931 a joint board, consisting of the Metropolitan District Commission and the State Department of Public Health, suggested, as one means of relieving the Charles River sewer, the extension of the high-level sewer from Oak Square through and across the city of Newton. The Legislature later authorized the extension as far as the Newton line, with the understanding that Newton would construct a high-level sewer to connect with it. In 1932 the Newton end of the problem was studied in detail by the author's firm, and plans were prepared for the construction of that part of the Newton high-level sewer from a point on Tremont Street at the Brighton line to Walnut Street, Newtonville. The relation of the Newton high-level sewer and the metropolitan sewers serving Newton is indicated on Fig. 1.

DESIGN DATA

The Newton high-level sewer is designed to meet the expected needs in the year 1970, at which time it is estimated that 76,300 persons will occupy the 5,524 acres of habitable area in the high-level district of the city of Newton. This is about one-half of the total habitable area of the city, which is 10,840 acres.

The sewer, as indicated in profile on Fig. 2, is designed for a maximum of 400 gallons per capita per day, and varies in size from 36 inches at its upper end in Newton Lower Falls to 63 inches (equivalent diameter) at and above its junction with the metropolitan sewer. The capacity at the lower end is 30.4 million gallons per day. The total ultimate length of the sewer is 5.4 miles, in which distance the invert of the sewer drops 16 feet. About half of the ultimate length will be in tunnel.

INITIAL CONSTRUCTION

The Newton trunk sewer most urgently requiring relief was that in Walnut Street, Newtonville. It was determined, therefore, that the initial construction should extend from Walnut Street at Cabot Street easterly to the Brighton line, intercepting several existing sewers *en route*, a distance of two miles (Fig. 3), of which 0.9 mile is in tunnel, and in which the invert falls 3.35 feet.

The portion of the sewer selected for initial construction serves 2,785 acres of habitable area, upon which it is estimated that 38,400 persons will live in 1970, and from which sewage at the maximum rate of 15.3 million gallons per day will be contributed. This is about one-half of the ultimate design capacity, the remainder of which is reserved for the areas west of Walnut Street. The design called for a diameter

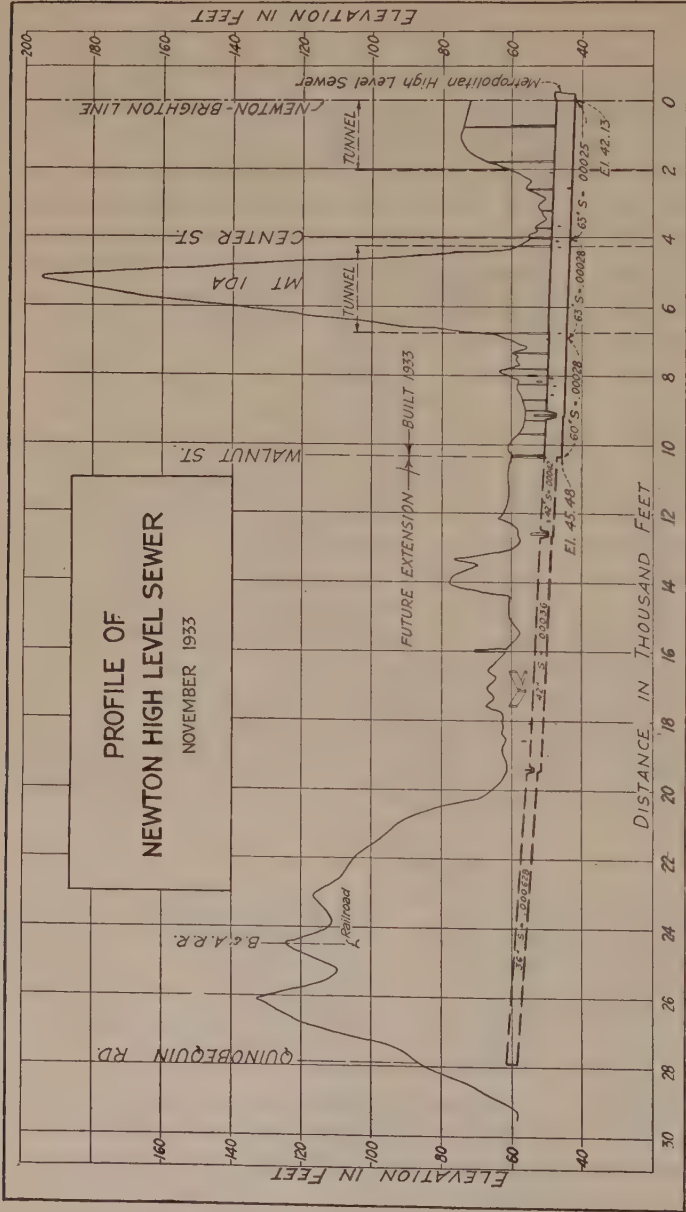
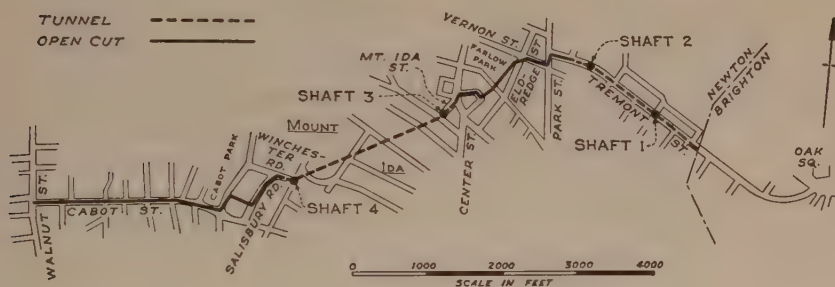


FIG. 2

of 60 inches from Walnut Street to Center Street, and 63 inches east of Center Street. For practical reasons, however, the 63-inch size was continued to the westerly end of Mount Ida tunnel in order to utilize the same forms for all tunnel work.

ORGANIZATION FOR CONSTRUCTION

Late in 1932 the unemployment problem became acute in Newton, and Mayor Sinclair Weeks, with the approval of the board of aldermen, decided to undertake the construction by force account, employing Newton residents so far as practicable. The type and magnitude of



NEWTON HIGH LEVEL SEWER
PLAN OF 1933 CONSTRUCTION

FIG. 3

the undertaking dictated that it should be managed by an experienced contracting organization. Arrangements were accordingly made with T. Stuart & Sons Company, headed by Mr. F. H. Stuart, a Newton resident, to furnish all equipment and manage all construction operations. Superintendents, foremen and other key men in positions of responsibility, and the tunnel crews, which required special qualifications and training, were left in the control of the contractor. All others were to be assigned through the welfare organizations of the city.

The work was under the direction of Mr. George E. Stuart, street commissioner, and Mr. Wm. P. Morse, city engineer, for whom the author's firm attended to all details of field engineering.

A set of books was kept, entirely independent of those of the contractor's regular establishment, and a complete set of forms was devised for recording material requisitions and pay rolls, all of which were checked and approved by the field engineering staff and by the city

engineer and the street commissioner, before the contractor could be reimbursed by the city.

SEWER IN OPEN CUT

The sewer in open cut is constructed of monolithic reinforced concrete for about 2,200 feet between the two tunnels and 3,580 feet west

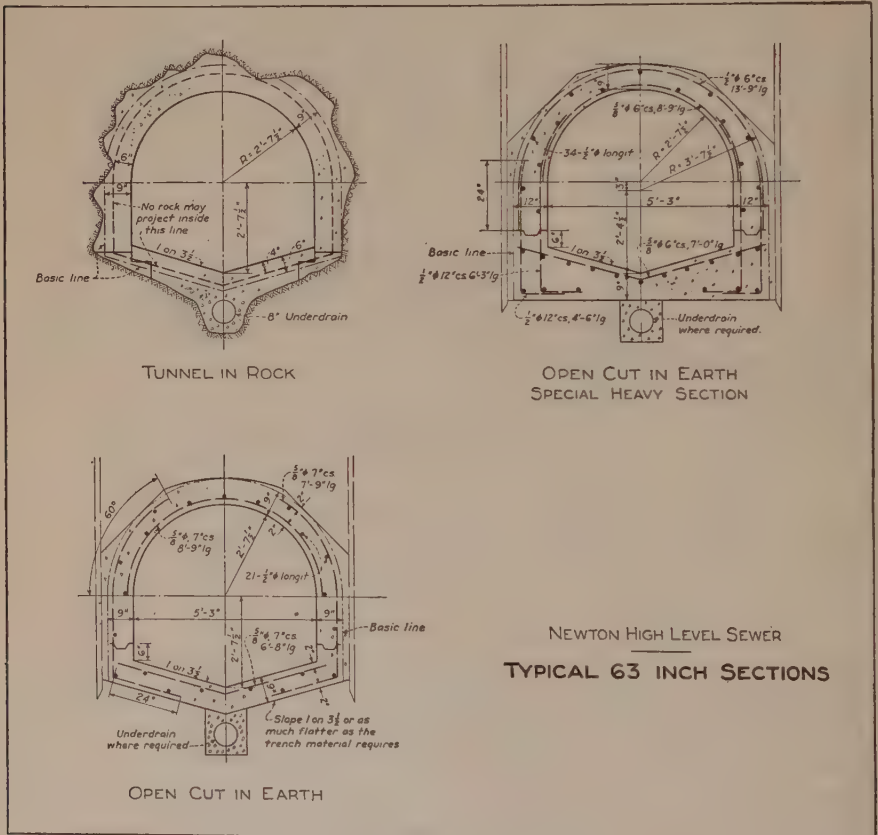


FIG. 4

of the Mount Ida tunnel. The section was designed to carry an expected load of about 11,000 pounds per linear foot, due to backfill and to superimposed traffic loads. Instead of a full circular section which requires bottom forms for the invert as well as for the arch, an equivalent cross section (Fig. 4) was selected, which has a flat V-shaped invert with vertical walls below the springing line. This permits the invert to be poured without forms.

The open cut portion of the sewer was everywhere constructed in close sheeted trenches, some sheeting being driven by hand and some by air hammers. East of Mount Ida the material varied from gravel to hardpan, some clay being in evidence practically everywhere. West of Mount Ida the material was mainly clean sand, which was unstable when saturated. Excavation was largely done by steam or gasoline driven clamshell bucket, considerable hand labor being used for trimming and moving material within reach of the bucket. In a few places material was shoveled by hand into skips and hoisted to the surface.

Provisions for handling ground water during construction were necessary in about half of the excavation east of Mount Ida and everywhere west of Mount Ida. Drainage was provided by the use of vitrified pipe underdrains surrounded with screened gravel, except where running sand was encountered. For several hundred feet west of the Mount Ida tunnel well points were necessary in order to lower the ground water level and stabilize the extremely fine sand which could not be otherwise controlled. The Moretrench equipment which was used for this purpose was admirably adapted for meeting these conditions. Well points were also used in the special construction beneath the Laundry Brook culvert on Cabot Street, and to control one or two other local recurrences of extremely fine water-bearing material elsewhere on Cabot Street.

In order to minimize the width of trench, the sheeting was driven practically on the neat line of concrete, an inch or two of extra width being allowed on each side to provide for any inadvertent misalignment of sheeting. The concrete was poured directly against the sheeting which was first covered with an inexpensive building paper in order to permit the withdrawal of the sheeting without injury to the concrete. Sheeting was left in place in a few places where the safety of adjacent structures made this procedure seem desirable.

Forms were made up in 6-foot straight lengths, and were of wood faced with sheet iron. Curved forms, on a 10-foot center line radius, were made up in varying lengths such that combinations could be assembled to fit every change of direction. The use of wooden forms rather than steel forms was dictated by the desire to perform locally a maximum of the necessary labor.

Reinforcing bars of re-rolled rail steel were used at a saving of \$3 per ton over new billet steel. Some difficulty was experienced with this steel, due to its hard and springy character, which made it difficult to correct any inaccuracies in the bending of the steel as it was received on the work.

Transit mixed concrete was used throughout the work, both in open cut and in tunnel. The price was \$5 per cubic yard for 1:2:4 concrete

using ordinary Portland cement, and \$6.25 per cubic yard using high early strength cement. It was felt that the higher cost of concrete mixed on the job did not justify the latter method merely to create an added amount of home labor.

High early strength cement was used on all open cut work until about April 1, in order to minimize the length of time of heating, which was done with steam or with salamanders, the trench being covered with tarpaulins over newly poured concrete. The concrete was placed in two operations; first, the invert, with about 6 inches of the vertical walls, and later, after the invert had set, the walls and arch were poured. Vertical construction joints of the tongue and groove type were provided, not over 36 feet apart.

An unusually mild winter permitted open cut construction to proceed almost without interruption from the outset.

SPECIAL STRUCTURES

Interference with existing water courses required special structures where the sewer crossed over a large drain in Eldredge Street, and at the crossing beneath Laundry Brook on Cabot Street. At Eldredge Street the sewer was carried over the drain without change in interior dimension, the drain being carried beneath the sewer, and the roof of the drain being depressed to form a Venturi-shaped flume which it is believed will pass the expected quantities of storm run-off in this drain without serious loss of head. At Laundry Brook the excavation was carried beneath the existing concrete culvert, which has a square span of 15 feet with abutments each about 4 feet thick. The length of the crossing is about 50 feet, exclusive of junction chambers, due to the sharp skew of the intersection.

Four 24-inch circular conduits are carried beneath this culvert, and are connected with the standard sewer section at either end in a junction chamber designed to minimize the loss of head. These conduits consist of $\frac{1}{4}$ -inch welded steel pipe surrounded with concrete, the pipes acting primarily as forms for the concrete.

At Walnut Street, where a junction was made with the existing 2 feet by 3 feet brick trunk sewer, provision was made for the future connection of a 45-inch westerly extension of the high-level sewer.

The flow in the several sewers which were to be connected with the new structure was provided for during construction in two typical ways. Those existing sewers which intersected the new sewer were carried, unbroken, through the new structure. In those sewers whose grade was above the new work, branches were inserted which were ex-

tended downwards into the new sewer and plugged. When ready to connect, it was a simple matter to go through the sewer and remove the plugs or break out the pipe and brick up downstream openings. Numerous house connections were similarly handled.

TUNNEL

The sewer was constructed in rock tunnel under Tremont Street from the city line a distance of about 2,080 feet to a point about 300 feet east of Park Street; and under Mount Ida for a distance of approximately 2,340 feet from Mount Ida Street to Winchester Road, passing beneath private property for much of this distance.

Earth was found for a few feet in the roof of the Mount Ida tunnel just before it ran into open cut, at the westerly end near the corner of Winchester Road and Salisbury Road, and about 125 feet of earth tunnel was driven at the easterly end in Mount Ida Street.

Easements under private property were taken in a 20-foot square prism centered on the axis of the tunnel. This provides ample working space and imposes much less encumbrance upon the title to and use of the property than when the easement is taken between vertical planes.

In the rock tunnel the material encountered was, for the most part, a seamy shale, although some conglomerate occurred, much of which was so badly disintegrated as to make it scarcely distinguishable from very dense hardpan. In some places in both tunnels, and particularly in the Tremont Street tunnel, the shale was also somewhat disintegrated, having broken down into thin laminations and being interspersed with mud seams. In such places pressed steel liner plates were used on the roof to protect the workmen, a semicircle of these plates being supported by timber sills on posts at either side. Elsewhere no support was required except in a few places where timbering was used locally to support blocks of rock, which appeared to be loose or threatening.

Four shafts were sunk, two on each tunnel. In the Tremont Street tunnel, Shaft No. 1, 32 feet deep to the sewer invert, was located about 760 feet west of the city line, and Shaft No. 2, 25 feet in depth, was about 1,040 feet further west. The tunnel was driven in both directions from each of these shafts, but only a single heading was worked at a time in each shaft.

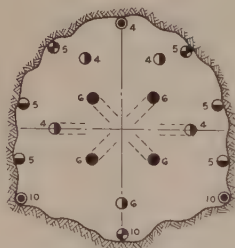
Shaft No. 3, 27 feet in depth to the invert, was located in Mount Ida Street, and about 2,170 feet away, in Winchester Road, Shaft No. 4, 43 feet deep, was sunk. One heading was first driven beneath Mount Ida in each of these shafts, until closure was effected, after which the short approaches to connect with open cut were driven.

It was possible to locate the shafts at angles in the tunnel line. This eliminated all turns within the tunnel, except at one flat angle just west of the city line, which was inserted to simplify the construction of the transition between the Newton sewer and the metropolitan sewer.

Each shaft was heavily timbered and surmounted with a timber framework carrying an I-beam which projected out beyond the excavation. The skips hoisted from the shaft were run out on this I-beam and

ATLAS CAP No.	TIME INTERVAL (SECONDS)	SYMBOL	No. OF HOLES	No. STICKS OF DYNAMITE EACH HOLE	TOTAL
0		●	4 *	6	24
1	1.4	①	4	4	16
	.5		1	6	6
2	.5	②	4	5	20
3	.5	③	2	5	10
			1 *	10	10
4	.5	④	2 *	10	20
			1	4	4
TOTAL			19		110

* 60% DYNAMITE - REMAINDER 40%



NEWTON HIGH LEVEL SEWER
MT. IDA TUNNEL
TYPICAL DRILLING
AND
LOADING PATTERN

NOTE: FIGURES DENOTE NUMBER OF STICKS OF DYNAMITE IN EACH HOLE FOR 6-FT ROUND.

FIG. 5

dumped into trucks. The hoisting engines were operated by compressed air. Air compressors at each shaft were of the gasoline-driven, portable type, but were temporarily housed to minimize noise and provide shelter for the operators.

Drilling in the tunnel headings was done with Ingersoll-Rand high-speed drifters, two in each heading. The number and arrangement of holes varied considerably according to the nature of the rock, and to some extent according to the practice and technique of the foreman in

charge. Fig. 5 shows a typical drilling pattern used for sound rock in the Mount Ida tunnel. This pattern contains 19 holes and was loaded with about 55 pounds of dynamite. Each round was fired at a single throw of the switch and advanced the heading about six feet. Instantaneous fuses were used in the cut holes and four stages of time delay fuses in the remainder of the holes, so that there were five distinct explosions in the firing of each round. In the typical pattern, 60 per cent dynamite was used in the cut holes to assure the removal of the cut and in the three bottom or lifter holes to sharply turn back the muck accumulated from earlier shots in the round, breaking it up for easier shoveling and clearing the heading to make it quickly accessible for further drilling operations. Forty per cent dynamite was used elsewhere.

Forty-one thousand pounds of dynamite were used on the work, or about 5.2 pounds of explosive per cubic yard of excavation. About one-sixth was 60 per cent and the rest 40 per cent dynamite.

Muck was loaded by hand shovel into special one cubic yard steel skips carried on 24-inch gage car trucks which were pushed by hand to the shaft. At intervals of about 500 feet the tunnel excavation was widened to permit the construction of a siding, so that incoming and outgoing cars could pass and thus avoid delays in loading muck at the headings.

Drainage was accomplished by the use of 8-inch tile under-drains terminating in sumps at the shafts where small motor-driven centrifugal pumps were installed.

Ventilation of the tunnel was accomplished at each shaft through a 14-inch galvanized iron pipe which was carried well up toward the heading. Air could be either exhausted from or forced into the tunnel by the adjustment of blast gates near the motor-driven blower of about 3,000 cubic feet per minute capacity, which was located near the head of each shaft, well above the ground surface.

The tunnel was lighted by electricity. The lighting wires were carried, as a precautionary measure, on the opposite side of the tunnel from the wires used for blasting.

The compressed air pipe and the water pipe which served the drills were located on the floor of the tunnel at one side. The arrangement of these utilities is shown in Fig. 6.

The stratified character of most of the rock made it difficult to hold the excavation closely to the "pay line" (which would have been established had the work been done under unit price contract). The "pay line" would have provided for a 12-inch thickness of concrete in walls and roof and a 9-inch thickness on the floor, although rock was

permitted to project within 4 inches of the concrete surface in the floor, and 6 inches in walls and arch. The actual excavation averaged between 2 and 3 inches outside of this line, resulting in an overbreakage of approximately 11 per cent.

After the tunnel excavation was completed, the lining was accomplished in three steps. In the first step a concrete sill was constructed at each side, each sill having a reference step carefully set to line and grade. Next, the walls and arch were placed, and finally the invert. Transit mixed concrete, with ordinary Portland cement, of 1:2:4 mix was used throughout in the tunnel lining.

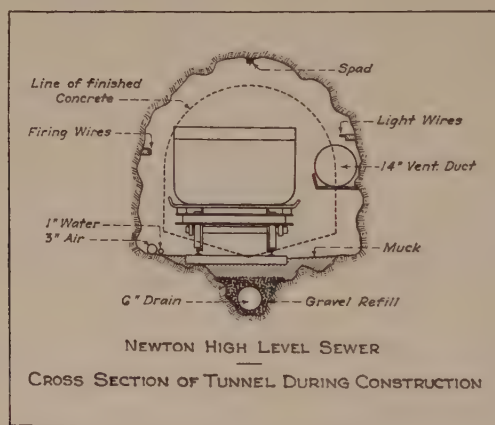


FIG. 6

The concrete for the sills was carried into the tunnel in muck skips, which had been modified by the addition of a removable bulkhead in the open end. After these sills were cast there was no longer any necessity for the line and grade party to enter the tunnel, which was advantageous, as delays are unavoidable when transit or level must be set up in the confined space of a small tunnel.

Forms for walls and arch rested on the step in the sills. The forms were of wood covered with sheet iron and were planned for convenience in erection, and removal to a new location. One panel was used at each side for the vertical part of the wall, and curved steel ribs resting on these carried two panels of curved forms on each side, leaving a space about 20 inches in width at the top in which the concrete blow pipe was carried, and which was later closed by inserting short wooden key blocks just ahead of the concrete.

Concreting of walls and arch was done with a 7 cubic foot Ransome pneumatic placer located at the foot of the shaft. A wooden hopper was erected in the shaft above the concrete gun into which concrete was dumped from a transit mixing truck and from which concrete could be drawn to the gun at will.

The forms were first erected at the far end of the section to be lined from a given shaft and the work then proceeded toward the shaft. Concrete was shot into place through a 6-inch steel pipe with flanged joints, laid along the floor of the tunnel until the forms were reached. Here a section of flexible pipe was inserted, permitting the pipe to be raised be-

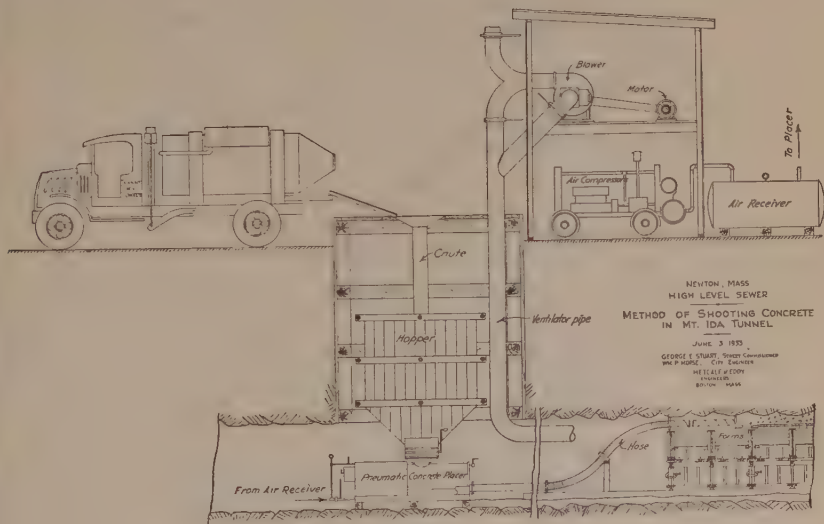


FIG. 7

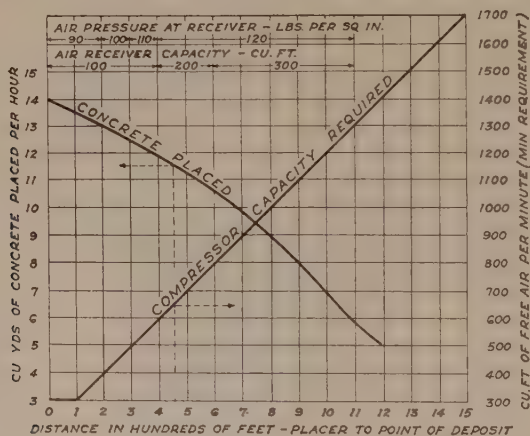
yond this point and carried on top of the steel arch ribs in the space from which the key blocks of the forms had been omitted.

The usual routine was to strip the forms from the concrete poured the previous day the first thing in the morning, erect them in the next section and start shooting concrete the latter part of the forenoon. Shooting was stopped about an hour before closing time to permit the cleaning of the hopper and the flushing out of the concrete gun and the discharge pipe line without overtime. Fig. 7 illustrates the arrangement of equipment for shooting concrete.

The required capacity of air compressors and air receivers and the necessary air pressure were found to vary with the distance from the gun

to the work. The rate of placing concrete was less the greater the distance. The greatest distance from the gun to the work was about 1,200 feet. This was in the Mount Ida tunnel, west of Shaft No. 3. The diagram, Fig. 8, indicates the results of experience with the concrete gun on the Newton work.

It was found desirable first to shoot a batch of wet, neat cement grout to lubricate the interior of the pipe and thus prevent loss of cement in the first few batches of concrete. Next, a batch of one-to-one mortar was shot to build up a cushion against the hardened concrete of the previous day's



NEWTON HIGH LEVEL SEWER
EXPERIENCE WITH RANSOME 7 CU FT.
PNEUMATIC CONCRETE PLACER

1933

FIG. 8

work, from which the first few batches of concrete would otherwise rebound and segregate. The size of these initial batches was regulated according to the length of pipe in use at the time.

Laborers were stationed to continually rap the forms with wooden mallets while concrete was being placed. The concrete was allowed to run down on the natural slope in the walls, but at the end of a day's work a sand bag bulkhead was built over the arch and concrete shot in to fill the space behind this bulkhead in order to avoid the feather edge which would otherwise occur at the top of the arch. When the sand bags were pulled out in the morning they left an irregular surface which formed an effective key of the new work into the old.

Where liner plates had been used in the roof of the excavation, every third or fourth ring of plates was removed just in advance of placing forms, and it was found that this permitted the concrete to flow in and thoroughly fill the spaces behind the liner plates.

Due to the overbreakage in excavation the concrete used for lining overran that measured to the theoretical pay line by about 24 per cent. Where overbreakage was excessive at the sides of the tunnel, as, for example, at track sidings, rubble filling was packed in advance of placing the forms to reduce the amount of concrete. No attempt was made to use packing in large cavities over the arch, as it was felt to be more economical to fill such spaces with concrete shot into place than to attempt to provide the supports necessary to hold such packing until the concrete lining was placed.

The placing of the invert was done by hand, after the gun had been removed from the shaft. Concrete was taken in on cars, as for the sills, and screeded to grade as established by wooden templates resting on the steps of the sills.

TUNNEL SURVEY METHODS

The overland surveys for establishing the tunnel line were made with a steel tape and an ordinary transit having a one-minute horizontal circle. Angles were repeated six times and distances were measured twice, once in each direction. Tension and leveling of the tape was determined by judgment without resort to the use of a spring balance or level. A wye level was used for obtaining elevations.

The survey for the Tremont Street tunnel was comparatively simple, since the surface survey followed the true line of the tunnel. For the Mount Ida tunnel a traverse was carried from the easterly end of the proposed tunnel around the northerly flank of Mount Ida to the westerly end of the proposed tunnel, and then continued on to the starting point around the southerly flank of Mount Ida. This traverse closed with an error of 1 in 60,000.

The calculated center line of the tunnel was transferred down the shaft by means of two 28-pound plumb bobs suspended on No. 7 music wire having a diameter of 0.017 inch. The plumb bobs were constructed of steel plates fitted edgewise in the shape of a cross, supplemented by window weights, and were hung in pails of oil to prevent oscillation. Devices for adjusting the wires by slow motion screw and reels for raising and lowering the plumb bobs were home-made from parts of inexpensive wood-turning equipment which can be obtained at any mail-order house or in the chain stores. On each end of a short section

of lathe bed, there was mounted a tail stock turned at right angles to its normal position. To the threaded spindle of one tail stock was attached a $1\frac{1}{2}$ -inch pulley with a V groove over which the wire passed leading to the plumb bob. This threaded spindle could be moved axially to bring the plumb wire on to line by means of the tail stock hand wheel.

The threaded spindle and hand wheel were removed from the other tail stock and a plain spindle substituted, upon which was mounted a 6-inch pulley. On this the surplus wire was reeled, the spindle being fitted with a crank and ratchet for operating and locking the reel.

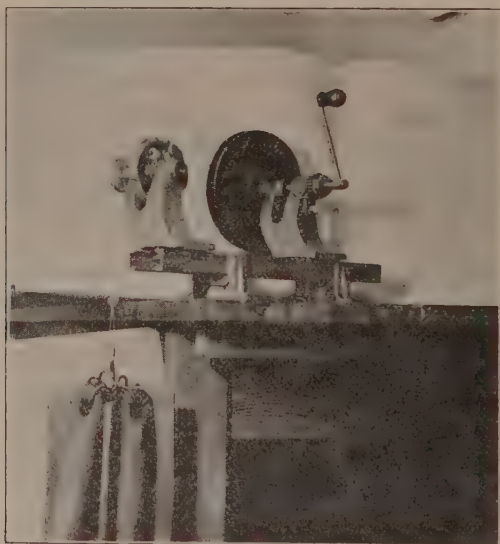


FIG. 9. — DEVICE FOR PLUMBING DOWN
TUNNEL SHAFTS

Two of these devices were made and moved from shaft to shaft as required. They were screwed to rigid timber tables permanently spiked at convenient points just to one side of the line at the top of each shaft. The wires were then lowered with light temporary weights attached, which were replaced with the heavy plumb bobs when the ends of the wires reached the bottom of the shaft. Fig. 9 shows one of the plumbing devices. The two wires were next brought accurately on to line by means of a transit set up at a reference point on the surface, after which another transit was worked on to line in the tunnel. The line was then transferred to previously prepared concrete monuments in which

wrought-iron straps had been inserted, the lines being marked on these straps with a cold chisel and center punch.

The first two monuments in each shaft were approximately 30 and 230 feet, respectively, from the portal. Subsequent monuments were located at approximately 200-foot intervals and marked by extending the line from the first two monuments. The line was again verified by the use of the plumb wires after the tunnel had penetrated about 700 feet from each shaft.

Work on tunnel alignment using the plumb wires was done on Sundays or holidays, as it occupied several hours and would have otherwise seriously interfered with the progress of work in the tunnel. Visibility was also better at these times.

Reference points for the use of the tunnel workmen were provided by setting spads in the roof of the tunnel over the center line. At intervals of from 50 to 100 feet holes were drilled on the center line in the roof of the tunnel and wooden plugs were driven into the holes. Small wire hooks were screwed into these wooden plugs after being set carefully to line by transit. Levels were taken on these spads and the length of chain determined to bring the flame of a plumb lamp exactly at the tunnel axis. By the use of two such lamps suspended from adjacent spads near the heading, the heading foreman was able to sight through and mark his heading.

The following tabulation shows pertinent data relative to the tunnel survey work:

SHAFT NUMBER	Length of Base Line between Wires (Feet)	Distance between Shafts (Feet)	ERROR OF CLOSURE	
			In Line (Feet)	In Grade (Feet)
1	10.56	1,040	0.0	0.01
2	13.54			
3	16.07			
4	11.11			
		2,170	0.3	0.01

The line of the tunnel, which was driven 760 feet easterly to connect with the metropolitan tunnel, met the latter within less than 0.1 foot, and the grade checked exactly.

PROGRESS

Work was started on December 21, 1932, and was completed, including all repaving, on August 26, 1933. In thirty-five weeks, 10,300 feet of 60-inch and 63-inch sewer were built at the average rate of 295 feet of completed sewer per week. The metropolitan sewer east of the Brighton line was ready for service a few days later, and all the connecting sewers which the high level sewer was designed to intercept were connected with the new sewer by September 1, 1933.

With two crews working, one east and one west of Mount Ida, progress on the open cut portion of the work averaged about 200 feet of completed sewer per week, or about 100 feet per crew. This was equivalent to one invert section every other day, and one section of wall and arch on the alternate days, for each crew.

The tunnel work was carried on for two 8-hour shifts, at each of four headings from 6 A.M. to 10 P.M. The night shift was omitted to avoid the annoyance of the resulting noise in the residential district in which the work was located. Driving of the bore in the Mount Ida tunnel averaged 72 feet per week per heading, and in the Tremont Street tunnel, 66 feet per heading. The maximum week was 114 feet per heading in the Mount Ida tunnel, and 105 feet in the Tremont Street tunnel.

The concrete sills for tunnel lining were placed at the rate of about 500 feet per week. The pneumatic placing of walls and arch averaged 400 feet per week, including time lost in shifting equipment from one shaft to another, and the invert was placed at the rate of from 700 feet to 1,000 feet per week.

GROUND WATER LEAKAGE

After completion of the sewer, and after the ground water had had an opportunity to reach its normal level following discontinuation of pumping, the finished sewer was carefully examined for leaks and the necessary repairs made. The final measurements of leakage of ground water just prior to placing the sewer in service showed that the low rate of 10,000 gallons per day per mile was finding its way into the sewer.

SAFETY MEASURES

On account of the hazardous nature of the work, particularly that in the tunnel, every reasonable precaution was exercised to minimize accidents. First-aid kits were kept at all shafts and in the tool houses

of each of the open cut crews. There were no fatalities, and although the usual number of cuts and bruises were experienced, only one serious accident occurred. This accident occurred when three men were injured by the fall of a mass of broken rock from the roof, which had become loosened by a previous blast, and which partially buried the men while they were shoveling on the muck pile. All of these men recovered, although one was in the hospital for several weeks.

In order to prevent the accidental firing of explosives in the tunnel headings the firing switch was located at the head of the shaft in a special locked box. Before these wires could be energized from the 110-volt lighting circuit which was used for detonating the explosive, it was necessary that the heading foreman, who was the last man to leave the tunnel prior to blasting, should unlock the box, screw in the fuses which he carried in his pocket, insert a plug which closed a gap left for protection against lightning, and then throw the knife switch. The switch box was arranged so that it could not be closed unless the knife switch and the lightning gap were both in the open position. A prominently painted sign posted near this box warned persons not to enter the tunnel if the box were open.

The rule was made that all men working in the tunnel should wear hard fiber helmets, and these were found to be effective not only against rock fragments falling from the roof, but also against head injury in the low headroom of the tunnel.

An effort was made to limit the use of dynamite, so as to minimize complaints from residents. In a normal round the instantaneous or cut shot caused the most pronounced reaction because its function was to start the cycle by forcing the core out of the solid face of the heading, while the subsequent delay shots merely crushed the rock in front of them into the cavity left by the cut. The delay shots sounded much like relatively faint echoes of the instantaneous explosion. On the other hand, it was found that if charges in the cut holes were too far diminished, their failure to pull the cut increased the severity of the shock, because the subsequent delay shots, finding no cavity into which to expand, reacted more sharply against the surrounding ledge.

Many tests were made in houses from which complaints came, using $\frac{1}{4}$ -inch steel pins of lengths varying from 4 inches to 17 inches balanced on a carefully leveled steel plate. In no case was there sufficient jar from blasting to tip over a single pin. In certain buildings, however, it was possible to tip several of the longer pins by walking heavily across the floor. The reaction of an explosion upon the human nervous system is the combined result of noise, air concussion (evi-

denced by rattling of windows) and the actual jar due to the pressure wave coming from the ground. The last may be insignificant and yet a nervous person may honestly believe his house is about to be destroyed. The pin test device is shown in Fig. 10.



FIG. 10. — "PIN TEST" DEVICE FOR SHOWING
BLASTING VIBRATION

CONSTRUCTION COST

The total construction cost of the high-level sewer was \$404,700. Of this, approximately 43 per cent was expended for labor. The average cost of the completed tunnel was \$49.23 per linear foot. The sewer in open cut east of Mount Ida cost \$26.31 per linear foot, while that west of Mount Ida cost \$33.95 per linear foot. This difference was due primarily to the greater depth of excavation and the greater difficulties with ground water west of Mount Ida.

THE TENNESSEE VALLEY AS AN EXPERIMENTAL LABORATORY

BY WILLIAM BENJAMIN WEST, MEMBER

IN his "History of the American People," Woodrow Wilson pointed out that the people of several States situated in the south central part of the United States, including Tennessee, Kentucky and part of Virginia, followed the conservative course in the election of 1860 which contributed toward the splitting of the Democratic party and the election of Abraham Lincoln. These people, residing mostly in the Appalachian Mountains or on the plateau, disapproved of the demands of the more radical element of the Democratic party for an immediate showdown on the slavery question. Instead, they contended that there were other equally pressing questions before the national government, such as the immigration question, and that time would solve the vexing slavery problem.

It is interesting to note that this same historian — later to become our World War President — was destined to sign the Muscle Shoals bill which would ultimately be enlarged upon by one of his successors — and incidentally his former Assistant Secretary of Navy — so as to embrace the most far-reaching experiment in social, agricultural and industrial development and reconstruction in the very heart of this area ever undertaken.

With the signing by President Roosevelt of the "Tennessee Valley Authority Act of 1933," on May 18 of last year, there was called into being a corporation "clothed with the power of government, but possessed of the flexibility and initiative of a private enterprise," which was later set up for the purpose of conducting operations which, five years ago, would have been laughed into discard at their very mention.

While the Seventy-third Congress granted many unusual powers to President Roosevelt during its recent extraordinary session, yet all of these measures except the Tennessee Valley Act of 1933 were of comparatively recent origin, and may therefore be largely attributable to the prevailing world economic conditions as they have affected the social order in the United States.

This act granted the President power to appoint, by and with the consent of the Senate, a group consisting of three members whose

responsibility it is to develop the natural resources of the Tennessee River basin along broader lines than ever heretofore undertaken, including the completion and operation or lease of the government properties at Muscle Shoals which, as most every one knows, were started during the World War primarily for the manufacture of nitrates for explosives, and secondarily as a possible source of nitrates for plant food during peace times.

The national controversy over Muscle Shoals raged from the very beginning of the undertaking to the height of the depression which began in November, 1929, after which time the people had other large problems to be solved and therefore let this subject rest until the latter part of 1932, when Mr. Roosevelt, in his campaign for the presidency, promised to interest himself in this undertaking.

In the latter part of 1921 Congress refused to appropriate funds to carry on the construction of Wilson Dam, which, as a part of the Muscle Shoals program, had not been completed before the signing of the Armistice, and later in that year Honorable John W. Weeks advertised the entire property for sale.

Various offers for the purchase of Muscle Shoals were received, many of which were the fruits of long and expensive studies by the bidders. Certain financial and chemical leaders of the East, and public utility people in the South, sought, with evident sincerity, to evolve a plan which would be fair to the government and yet at least protect their own investors. What the plight of any one of these bidders would have been since 1929 had their offer for Muscle Shoals been accepted, no one can tell.

But the wishes of those who wanted to see the government's original program at Muscle Shoals carried out finally prevailed, so the Tennessee Valley Authority is now a going concern with its main office at Knoxville, Tennessee, and other offices at Washington, D. C., Chattanooga, Tennessee, and Muscle Shoals, Alabama.

Two Muscle Shoals investigating commissions had previously been appointed by as many Presidents, but the resulting reports were not effective, because they served to further concentrate public attention upon the subject of "Muscle Shoals," which had long since become the symbol for political conflict between those who favored private enterprise — either in the nitrate field or the public utility business — and public ownership advocates. These same two Presidents each vetoed a bill providing for government operation at Muscle Shoals.

However, it remained for Mr. Roosevelt to come forward after the election of 1932 with a plan which would not concentrate public

attention on Muscle Shoals as such, but would scatter public interest over broader areas, and at the same time embrace the possibility of later extending the whole idea over other large sections of the country. Thus he was able to obtain at least silence among large numbers of those who have heretofore opposed Muscle Shoals, if not, indeed, their active support. Moreover, in comparison with some of our other national problems during the last half year, Muscle Shoals and the Tennessee River proposition were considered of less importance in so far as immediate results are concerned, although over a long period of years the Tennessee Valley Authority Act of 1933 may become the most far-reaching measure enacted by the extra session of the Seventy-third Congress.

So, whereas Muscle Shoals was originally authorized while we were at war with a foreign foe, yet it seems destined to be revitalized, and the original plan has been enlarged during a domestic economic conflict.

EXTENSIVE PROGRAM OF DEVELOPMENT

The Roosevelt program, as announced prior to March 4, 1933, also includes the improvement of navigation on the Tennessee River which will be linked with flood control on that stream and possibly eventually on the Mississippi River of which it is a tributary; reforestation which is now mitigating the unemployment situation; utilization of so-called marginal lands which had been overworked for agricultural purposes; and finally the development of great blocs of power for the further industrialization of the entire Tennessee River Valley area. Admitting that this would be a gigantic Federal experiment upon a scale never heretofore undertaken, he also suggested the possibility of carrying the idea further into other regions if the Tennessee River basin project indicated that it would succeed.

The Tennessee Valley legislation as finally enacted follows closely the two previously vetoed measures so far as nitrate manufacture by the government and power generation and possible power transmission, also by the government, are concerned, but decidedly outdistances these former measures when it comes to reforestation and marginal lands, as nobody ever before suggested such a comprehensive scheme as Mr. Roosevelt put forward. The idea of dealing with an entire river system as a whole for power purposes is not a new one, however, since it is well known in engineering circles that utilities and other water users have developed entire river systems, or have projected and started such enterprises by building several dams and control works on one stream and

able area used for the growing of crops in the entire nation of Japan. Seventy-five per cent of all the land in cultivation in our country is being seriously affected by the forces of erosion. A single rain in the famous cotton-growing Black Belt of Texas on the tenth day of May, 1930, washed away top soil from average slopes at a measured rate of 23 tons per acre. It was estimated that this single rain alone carried away and destroyed a total of 100,000,000 tons of some of the best soil to be found anywhere in the United States. The Mississippi River alone carries into the Gulf of Mexico in a single year 418,000,000 tons of solid matter. And whereas forests can be replaced in from fifty to one hundred years, the replacement of these soils is estimated by the Department of Agriculture to take from three hundred to a thousand years.

In the Tennessee Valley, land in many places is cultivated on slopes so steep that the farmers actually anticipate that the tillable soil will be washed off in from three to ten years, — a soil which takes several centuries to rebuild. The greatest tragedy of all this is that with such destruction going on, these men labor under intolerable conditions and secure the niggardly yield from these slopes of ten bushels of corn and eight bushels of wheat to an acre.

As to how the Tennessee Valley Authority would cope with this situation, the following statement by Mr. David E. Lilienthal, Director of the Tennessee Valley Authority, may be cited:

Fundamentally the problem is one of planning by governmental agencies, state and Federal, and for the Authority. The first step is the inventory and the classification of the land in the Tennessee River Valley. Those lands that are subject to this appalling erosion should not be used for open cultivation, but should be covered by some form of plant life that will hold the moisture and thereby prevent erosion. Instead of men wearing their lives out to get a precarious living out of lands not really suited for farming, the valley should be charted and planned so that agriculture will be carried on only on the land best adapted to it. This may involve vast governmental acquisition of so-called submarginal lands and transfer of some farmers to lands better adapted to farming than those on which they live. Translating these objectives into action is definitely a part of the duties of the Tennessee Valley Authority.

POWER DEVELOPMENT AND DISTRIBUTION

The Tennessee Valley Authority is empowered to acquire real estate, by condemnation if necessary, and build dams, power houses and lease or construct transmission lines if some satisfactory plan of co-operation with existing power distributing agencies cannot be effected.

The advisability of authorizing the Board to construct its own

transmission lines if no agreement could be reached with existing public utilities was sanctioned only after a bitter congressional contest.

The Authority, or "Board," may sanction the interconnection of the government transmission lines with those of the privately owned and operated power companies in order to permit more economical operation of both the private and government systems.

Pursuant to these and other provisions of the act, the Tennessee Valley Authority and the four largest electric utilities operating in Alabama, Mississippi, Tennessee and Georgia entered into a comprehensive agreement, dated January 5, 1934, under which the Authority acquires electric facilities in a substantial territory in three States in which to conduct its power operations. The contract also stipulates power interchange rates between the Authority and the power companies and arrangements for furthering the sale of electrical appliances upon a co-operative basis. The contract terminates as soon as additional power is available to the Authority from Norris Dam, or at the end of five years, whichever is sooner.

The Board is authorized to produce, distribute and sell electric power, and the act declares that, so far as practicable, the government shall distribute the surplus power generated at Wilson Dam equitably among the States, counties and municipalities within transmission distance of the plant. It is authorized to maintain control over the re-sale price of all electrical energy generated at government plants within the Tennessee River Valley.

The Authority began this phase of its program on February 7, 1934, on which date power was first delivered to the city of Tupelo, Mississippi, which owns its own distribution system. The power comes from Muscle Shoals and flows over a transmission line purchased from the Mississippi Power Company.

Up to March 21, 1934, contracts to serve nine cities with a population of about 200,000 had been signed by the Authority. Of these localities, Knoxville, Tennessee, is the largest, while Tupelo, Mississippi, as previously indicated, is the first to be thus served.

INCOME

Five per cent of the gross income from the sale of power generated at government plants in Tennessee is to be paid into the treasury of that State with a like provision for power generated at any similar plant in Alabama; 2.5 per cent of the gross income from power generated at stations below Cove Creek and resulting from the use of water stored

at any government-owned reservoirs is to be paid to each State. This provision was written in in order to offset the advantages claimed for privately owned electric public utilities because of the large amount of taxes they pay to the States in which their properties are located.

MUSCLE SHOALS DEVELOPMENT

With presidential approval, the act authorizes the Board to complete the hydraulic and steam power plants at Muscle Shoals by installing additional generating equipment in the power house at Wilson Dam and the steam plant at Nitrate Plant No. 2.

The Board is authorized to experiment with nitrate production for fertilizer and explosive purposes, to manufacture and sell nitrates for



FIG. 2. — WILSON DAM

explosives to the War and Navy Departments at cost, and to lease Nitrate Plant No. 2 for the production of commercial fertilizer or operate it for such purposes if no satisfactory offer is received. The Tennessee Valley Authority has set aside \$4,000,000 for the production of fertilizer, and pilot plants for such manufacture have been erected at Muscle Shoals, where Stone & Webster of Boston were commissioned to erect certain nitrate works. The fertilizers thus produced are being scientifically tested by the Agricultural Experiment Stations of the colleges of the seven Tennessee Valley States. The Authority has supplied the stations with quantities of fertilizers prepared in limited amounts at a small pilot plant operated by the Authority for experimental purposes. In this way the Authority expects to eventually determine the agricultural conditions and fertilizer needs of the respective States through the

co-operation of the college personnel which have long been engaged in similar research and investigation.

The act specifically directs the construction of Cove Creek Dam across the Clinch River some twenty-seven miles northwest of Knoxville, Tennessee, and authorizes the erection of a power transmission line now under construction, from Muscle Shoals to the Cove Creek power plant in order that they may be electrically interconnected. This dam will hereafter be known as "Norris Dam" in honor of Senator George W. Norris of Nebraska.

The Norris Dam is important as a flood-control measure, to say nothing of its value in river regulation for the improvement of navigation on the Tennessee River below the mouth of the Clinch River, and for increasing the primary power at all hydro-electric plants in the same stretch, including the Wilson Dam at Muscle Shoals, Alabama.

UNITED STATES ENGINEERS SURVEY OF TENNESSEE RIVER

In this connection it is interesting to note that in 1929 the United States Army Engineer Corps completed a survey of the Tennessee River basin for navigation, flood control and power development, which has been and probably will be of further value to those now entrusted with the development of that stream. No such thorough study of any river system and river basin was ever before undertaken. It was begun in 1922 and cost about \$1,000,000. The extent of the survey may be seen from the fact that in its making, 15,650 square miles of area were photographed from the air, the area mapped containing 5,800 square miles. Two thousand, two hundred miles of control levels were run out. Contours up to 200 feet or more above the river levels, where required by the survey, were plotted, with contour intervals of 5 and 10 feet. The topographic map and the river profiles occupy 388 sheets, each 27 by 40 inches, and the accuracy of mapping is of a high order.

From the report we learn that the Tennessee River is the fifth in size of any stream in the United States, and is the largest tributary of the Ohio, emptying into it at Paducah, Kentucky, 47 miles from the Mississippi. The low water discharge of the Tennessee at times exceeds that of the Ohio. It is formed by the Holston River, rising in the Great Smoky Mountains of Virginia, and the French Broad from North Carolina, which unite 4.5 miles northeast of Knoxville, Tennessee. It flows southwest across the eastern part of the State of Tennessee into Alabama, west across the northern part of Alabama, and north between Alabama and Mississippi and across the western part of Tennessee and Kentucky into the Ohio at Paducah.

RIVER AND TRIBUTARIES

With a drainage area of 40,600 square miles and a length of 652 miles, the Tennessee River drops 650 feet from its source to its mouth. In some sections it flows swiftly, though smoothly; in other places it is turbulent. The channel is cut through limestone for the most part. Frequently running through canyons sometimes as deep as 200 feet, the river spreads out in places until it is two or even three miles wide. In its upper reaches, its tributaries spread out like an immense fan to gather the heavy rainfall of the lower ranges of the Appalachian Mountains.

The Tennessee River and its tributaries, in their natural condition, are subject to wide variation of stream flow. The minimum discharge of the main stream at Florence, Alabama, in 1925 was approximately 4,300 cubic feet per second, while the maximum discharge in 1895 at this point was approximately 481,000 cubic feet per second. The average run-off at Florence is 53,300 cubic feet per second and at the mouth of the river it is 67,000 cubic feet per second.

In 1929 there were 23 hydro-electric plants with installed capacity of 370 kilowatts or more within the Tennessee River basin, the total installed capacity being 413,470 kilowatts. The government plant at Dam No. 2, Muscle Shoals, has an installed capacity of only 184,000 kilowatts, while with auxiliary steam installation it should have 340,000 kilowatts installation. It has a power house designed for the installation of 444,000 kilowatts.

A co-ordinate scheme of water-power development comprising 141 separate projects within the basin has been worked out, suggested designs presented, and an approximate cost estimate made. Also, an exhaustive economic study was made of the transportation facilities other than river traffic in the basin, and of the possible uses that might be made of the river if completely improved.

The area covered by the survey, most of which is also under the jurisdiction of the Tennessee Valley Authority, covers most of central and western Tennessee, extends widely over northern Alabama, includes portions of North and South Carolina and Georgia, and touches small portions of Virginia, West Virginia, Kentucky and Mississippi.

FLOOD CONTROL

In regard to flood control, the report holds that flood-control works on the Tennessee River would have practically no effect upon the Mississippi River floods, and that to operate reservoirs on the former with

the idea of reducing floods on the latter would seriously impair the value of the Tennessee as a power producing stream.

This places the Corps of Engineers of the United States Army on record as being in disagreement with one of the expressed objectives of the Tennessee Valley Authority Act, namely, "to control the destructive flood waters in the Tennessee River and Mississippi River basins." On the other hand, there are a number of prominent civil engineers in the United States who steadfastly contend that the maximum peak of excessive floods on the Mississippi River could at least be kept within the confines of levies by the construction of many storage dams on the upper reaches of several of its most important tributaries. Let us examine some of the facts in this connection.

According to this United States Army Engineers' report (House Document No. 328, Seventy-first Congress, second session) the useful storage of all existing and proposed reservoirs in the Tennessee River basin is 15,760,000 acre-feet. This volume of water would raise the surface of Lake Superior over 9 inches, or that of Lake Huron over 1 foot. It would be equivalent to a rainfall of five-sixteenths inch over the entire Mississippi River drainage area, which is 1,240,000 square miles, or would provide a flow of 265,000 cubic feet per second for 24 hours of every day for one month of 30 days.

The significance of this volume of storage can be appreciated when it is considered that the present Mississippi River flood-control program provides for a maximum flood of 3,000,000 second feet at the mouth of the Red River, 200 miles upstream on the Mississippi. One-half of that amount, or 1,500,000 second feet, will be allowed to go down the Mississippi. Assuming that one-half of the ultimate storage capacity of the Tennessee River basin is available for reducing the flood flow on the Mississippi River below the mouth of the Red River, this 1,500,000 second feet would be reduced to 1,368,000 second feet, and with the Bonnet Carre spillway, 28 miles above New Orleans, discharging in proportion to its capacity of 250,000 second feet when 1,250,000 cubic feet per second is going by New Orleans, this last quantity would become 1,140,000 cubic feet per second.

Whereas, as pointed out above, opinions differ as to the feasibility and practicability of flood control on the lower reaches of the Mississippi River by the construction of flood-control or storage dams on its tributaries, yet in regard to flood control on the Tennessee River by the construction of storage dams on its upper reaches, there is every evidence of agreement.

For example, the large Tennessee River flood of 1926 caused damages

amounting to approximately \$2,650,000. The above report embraces a study of the effects of the proposed system of storage reservoirs on that flood had they been in operation at that time, and indicates that the height of the 1926 flood would have been reduced by amounts varying from 8 feet at Knoxville at the head of the river to 12.8 feet at Johnsonville near its mouth. Such a reduction in flood heights would largely have prevented the damage which was caused by this flood, so the authors of the report claim.

From the same source we learn that the construction of the Norris Dam alone, which the Tennessee Valley Authority is now building, would have reduced the flood of 1926 at Chattanooga, Tennessee,



FIG. 3. — SITE AND COFFERDAM AT NORRIS DAM

from 38.4 feet to 32.7 feet. This reduction in depth of 5.7 feet from the crest of such a flood when it has already begun to enter the stores in a city of 120,000 people, which is the population of Chattanooga, can be translated only in terms of hundreds of thousands of dollars when savings in damage are being considered.

NORRIS DAM

Probably the most notable and certainly the most immediate service this report of the United States Army Engineers could be to the Tennessee Valley Authority is in connection with the construction of the Norris Storage Dam. Extensive borings have been made by the Engineering Corps at this and other sites, while surveys of the area by the same agency made possible the beginning of actual construction

much earlier than would have been possible had these original studies been necessary by the Authority after its establishment.

Plans for this dam call for a height of 253 feet from foundation to the roadway; a base width of 210 feet; over-all length of crest, 1,800 feet; and for a reservoir pool to inundate 35,000 to 52,000 acres, depending on whether the river is at normal or flood stage, this pool to form a lake of 3,600,000 acre-feet storage capacity covering some 800 square miles, with a shore line of over 800 miles. It will be about 41 miles long and 12 miles wide. The construction of Norris Dam will more than double the primary power at some of the hydraulic developments below on the Clinch River, across which it is being built one-third mile below the junction of Cove Creek and the Tennessee River. This lake will be one-fifth as large surface area as that of Lake Champlain in New York and Vermont, and its storage capacity would raise the surface of that body of water a vertical distance of over 7 feet.

Although Norris Dam was the only major barrier contemplated for several years by the Tennessee Valley Authority, yet in October, 1933, President Roosevelt, in an effort to provide employment for destitute people, directed the Authority to immediately construct General Joe Wheeler Dam (War Department Dam No. 3), near the head of Wilson Lake about $15\frac{1}{2}$ miles above the Wilson Dam, across the Tennessee River. This dam was started in November, 1933. It will be 50 feet high and approximately 6,000 feet in length, or some 1,000 feet longer than Wilson Dam. It will provide a reservoir of about 100 square miles in area which will extend up the river about 80 miles to Buck Island. This point is about five miles above Guntersville, Alabama. The Wheeler Dam will provide navigable waters nearly to Guntersville, Alabama, and will also serve to mitigate large floods. Navigation locks on the south side of the Tennessee River at the site of Wheeler Dam have been under construction by the War Department for several months. When the power market conditions demand, the Tennessee Valley Authority will install some 375,000 horse power of equipment according to present plans.

NEWLY ELECTED HONORARY MEMBERS, BOSTON SOCIETY OF CIVIL ENGINEERS

HONORARY membership in the Boston Society of Civil Engineers was conferred on the following members during the year ending March 21, 1934:

Harrison Prescott Eddy, a member since February 17, 1904, elected Honorary Member February 21, 1934.

Joseph Ruggles Worcester, a member since November 17, 1886, elected Honorary Member February 21, 1934.

At the annual meeting of the Society, held on March 21, 1934, diplomas of honorary membership were presented to Mr. Harrison P. Eddy and to Mr. Joseph R. Worcester by Mr. Arthur W. Dean, President. Prior to the presentation of these diplomas, a biographical sketch of Mr. Eddy was read by Prof. Harold K. Barrows, and a sketch of Mr. Worcester was read by Mr. Charles R. Main.

Harrison P. Eddy

BY HAROLD K. BARROWS

Harrison P. Eddy was born in Millbury, Mass., in 1870, the son of William Justus and Martha Augusta Eddy. He attended school at Worcester and graduated from the Worcester Polytechnic Institute in the course in chemistry in 1891.

He was superintendent of the City of Worcester sewage treatment plant and of the sewer department from 1892 to 1907, when, with the late Leonard Metcalf, he formed the engineering firm of Metcalf & Eddy, with which organization he has been associated ever since, becoming the senior partner at the death of Mr. Metcalf in 1926.

This firm in its twenty-six years of existence has held a leading position in the engineering fields of sanitation and water supply, including both a wide practice and going deeply into the allied fields of waterworks, sewerage and drainage systems, water, sewage and industrial wastes treatment plants and municipal incinerators. Among the cities served have been Louisville, New Orleans, Rochester, Springfield, Hartford, Cleveland, Buffalo, Syracuse, Akron, Dayton, Allentown, Boston, Cincinnati, Detroit, Milwaukee and San Antonio.

Mr. Eddy has given especial attention to sewerage and sewage treatment, and he is a well recognized authority in all the many appliances, methods, processes and researches which have been developed in this field. His ability has been recognized in assignments as expert witness in many important matters, including the United States Supreme Court cases of *New Jersey v. New York*, involving the use of Delaware River; *Connecticut v. Massachusetts* on the use of Swift River; *Wisconsin v. Illinois* and the Sanitary District of Chicago upon lake diversion; as well as serving as a member of the Engineering Board of Review of Chicago relative to the lake lowering controversy. At present he is engaged upon sewerage problems at Washington, D. C., and Portland, Ore., and is a member of the Technical Board of Review of the P. W. A. at Washington.

He is a co-author with Leonard Metcalf of "American Sewerage Practice" and of "Sewerage and Sewage Disposal," as well as of many technical papers and discussions. He has received the Desmond Fitzgerald Medal of the Boston Society of Civil Engineers, and the Hering and Norman Medals of the American Society of Civil Engineers for papers of much excellence.

Mr. Eddy is a member of many professional societies, including the American Institute of Consulting Engineers, American Chemical Society, American Society of Mechanical Engineers, American Water Works Association, New England Water Works Association, Engineering Institute of Canada, Institute of Sanitary Engineers and Institute of Civil Engineers. He has served this Society as its President and is now President of the American Society of Civil Engineers. He is thus a leading member of his profession and of national reputation.

He is fond of yachting and is a member of the Boston and Marblehead Yacht Clubs, the Pocasset Golf Club, Boston City Club, Old Colony Club, and Engineers Club of Boston and of New York.

He married Miss Minnie Locke Jones of Worcester in 1892 and has had four children, of whom one of his sons, Harrison Prescott Eddy, Jr., is a well known member of this Society.

RESPONSE BY HARRISON P. EDDY ON RECEIVING DIPLOMA OF HONORARY MEMBERSHIP

Mr. President and Friends of the Boston Society of Civil Engineers: In accepting this honor, I have some feeling of regret because I have not been able in recent years to take a more active part in the affairs of the Society. This has not been because of any lack of interest,

but rather on account of physical and other limitations which have made it impossible.

I am proud of this Society which has had a remarkable influence upon engineering in this country. Many of the Past Presidents of this Society have been outstanding figures in engineering in this country, and, in fact, abroad.

James Laurie, a founder of the Society and its first President, was instrumental in founding the American Society of Civil Engineers, and served as its President for a period of fifteen years.

Chesbrough, Francis, Freeman, Swain, FitzGerald and Stearns are some of those drafted from this Society to be presidents of the American Society of Civil Engineers. All of them were men of high engineering attainments and of sterling character, two attributes which have raised engineering to its high standard as a profession.

In calling attention to the accomplishments of these engineers, I want to make it very clear that in my opinion members of this Society, now living, have accomplished professional work which compares favorably with that of these engineers of an earlier generation.

It is a pleasure to be numbered among the honorary members of this Society, of whom there are three: C. Frank Allen, Charles T. Main and Karl T. Compton.

It is a source of gratification that I should have the opportunity of sharing the honors bestowed by the Society at this time with Mr. J. R. Worcester, whom I have admired as a man of high professional attainments and sterling character for the larger part of a generation.

Mr. President: I am sincerely grateful to you and to the members of the Board of Government who have voted to confer this honor upon me, and I desire to have the members of the Society at large know that I greatly appreciate it.

Joseph Ruggles Worcester

BY CHARLES R. MAIN

Joseph Ruggles Worcester was born in Waltham, Massachusetts, on May 9, 1860, being one of eleven children of Benjamin and Mary Clapp (Ruggles) Worcester.

For practically all his life Mr. Worcester has resided in Waltham. He prepared for college at the New Church School in Waltham, and was graduated from Harvard College with the class of 1882. The report of his class published in 1908 says of him: "Worcester is indeed

the Pontifex Maximus of the class, though he is far too modest to admit it."

Shortly before graduation he was employed by the Boston Bridge Works as a draftsman, becoming "engineer of the concern" in September, 1884. He remained with the Boston Bridge Works until October, 1894, when he started in business for himself as a consulting civil engineer. In March, 1907, he formed a partnership under the firm name of J. R. Worcester & Co., which has continued to date. In 1924 he retired from active practice in the firm, although continuing to the present time in the capacity of consultant.

Mr. Worcester is one of the foremost engineers in the country, specializing in the design of steel and reinforced concrete structures and in foundations.

For many years he had charge of the design of the steelwork of the Boston subway, and acted as consulting engineer to the Boston Transit Commission on many other engineering problems. Early in his career he was engaged to design the steelwork for supporting the dome of the Bulfinch State House in Boston. He also designed the steelwork for several large office buildings, the train shed (recently removed) of the South Union Station of the Boston Terminal Company, and most of the elevated structures of the Boston Elevated Railway. The steel arch bridge over the Connecticut River at Bellows Falls, Vermont, one of the first bridges of this type, is a conspicuous example of his work. The Boston Elevated viaduct across the Charles River Dam is another sample of his work.

One of our members has stated that as a young man he happened to see Mr. Worcester's stress diagram of the train shed of the South Station, and was greatly impressed with the precision of Mr. Worcester's work. Every line was clean cut, and in order to read the amount of the stresses accurately Mr. Worcester was using a magnifying glass.

Mr. Worcester has been a consulting engineer on many projects, and was a member of the commission charged with the building of the Hampden County bridge at Springfield, Massachusetts. As an expert witness, he has testified in numerous cases, one of which was the famous "Molasses Tank Case" of Boston.

A considerable amount of time has been devoted by him to the work of special committees of the American Society of Civil Engineers, of which he has been a member since 1895. His most notable contribution in this connection was membership on the special committee of the American Society of Civil Engineers on Concrete and Reinforced Concrete, which later became the "joint committee" of the American

Society of Civil Engineers, the American Society for Testing Materials, the American Railway Engineering Association and the American Concrete Institute. Mr. Worcester served on this committee from 1904 until 1917, and was elected its chairman in 1911. Pioneer work was done by this committee in establishing a code of design of reinforced concrete structures. In 1909 he was appointed a member of another special committee of the American Society of Civil Engineers on Steel Columns and Struts, and in 1920 a member of the special committee of the American Society of Civil Engineers on Bridge Specifications. For several years he served on a committee of the American Railway Engineering Association on Steel Bridges.

In 1921 he was appointed by President Hoover, then Secretary of Commerce, to a committee to formulate building codes and material standards, which appointment he retained until recently, when the work of this committee was taken over by the American Standards Association.

Mr. Worcester is also a member of the American Institute of Consulting Engineers, American Railway Engineering Association, American Society for Testing Materials, American Concrete Institute, Bostonian Society, Harvard Engineering Society (of which he has been a President) and the Rockport Country Club. He is also a Fellow of the American Academy of Arts and Sciences.

Mr. Worcester's membership in the Boston Society of Civil Engineers dates from 1886. In March, 1908, he was elected President of this Society. In 1914 he was awarded the Desmond Fitzgerald Medal for his paper on "Boston Foundations."

Mr. Worcester's interests are not confined to engineering. He has been a trustee of the Waltham Savings Bank and the Waltham Hospital, and is secretary for the New Church Institute of Education.

His fondness for the sea has attracted him to Rockport, Massachusetts, where he has spent the summers for the last sixty years. Of particular interest is an entry in his diary, "bought first dory at age of fifteen."

On January 2, 1889, he was married to Alice Jeannette Wheeler of Lincoln, Massachusetts. There were five children, four of whom are now living, including a son, Thomas, associated with his father in the firm of J. R. Worcester & Co.

MR. JOSEPH R. WORCESTER ACCEPTED DIPLOMA OF HONORARY
MEMBERSHIP

Mr. Worcester, in accepting the diploma, expressed his thanks to the Board of Government and to others who had been instrumental in presenting him with what he esteemed the greatest honor of his life. He said that in looking back over his fifty years of practice he was impressed with the fact that what success he had attained was largely due to four circumstances: (1) that, not having received a technical education, he was obliged to work the harder to acquire the necessary information; (2) that, while the period in which he began work for himself was a severe depression, it was also the time when skeleton construction first came to Boston, and reinforced concrete was in its infancy; (3) that he had been blessed with a remarkably faithful and helpful body of assistants, some of whom had been with him almost from the start and who should share in any credit he had received; (4) and finally to the inspiration and direct assistance he had received from older engineers, members of the Boston Society of Civil Engineers. He mentioned particularly J. Parker Snow, John E. Cheney, John W. Ellis, Howard A. Carson, George A. Kimball and George B. Francis, but he said that the list could be extended to include almost every member of the Society.

BOSTON SOCIETY OF CIVIL ENGINEERS

715 TREMONT TEMPLE, BOSTON, MASS.

ORGANIZED JULY 3, 1848



ACTS OF INCORPORATION

AN ACT

TO INCORPORATE THE BOSTON SOCIETY OF CIVIL ENGINEERS

*Be it enacted by the Senate and House of Representatives, in General Court assembled,
and by the authority of the same, as follows:*

SECTION 1. George M. Dexter, Simeon Borden, William P. Parrott, their associates and successors, are hereby made a corporation by the name of "The Boston Society of Civil Engineers," for the purposes of promoting science and instruction in the department of Civil Engineering, with all the powers and privileges, and subject to all the duties, liabilities, and restrictions set forth in the forty-fourth chapter of the Revised Statutes.

SECTION 2. The said corporation may hold real and personal estate not exceeding in amount twenty thousand dollars, and the funds or property thereof shall not be used for any other purpose than those declared in the first section of this act.

[Approved by the Governor, April 24, 1851.]

GEORGE S. BOUTWELL.

AN ACT

TO AUTHORIZE THE BOSTON SOCIETY OF CIVIL ENGINEERS TO HOLD ADDITIONAL REAL AND PERSONAL ESTATE

*Be it enacted by the Senate and House of Representatives, in General Court assembled,
and by authority of the same, as follows:*

SECTION 1. Section two of chapter sixty-nine of the acts of the year eighteen hundred and fifty-one is hereby amended by striking out the word "twenty," in the second line, and inserting in place thereof the words, "two hundred" so as to read as follows: SECTION 2. The said corporation may hold real and personal estate, not exceeding in amount two hundred thousand dollars, and the funds or property thereof shall not be used for any other purpose than those declared in the first section of this act.

SECTION 2. This act shall take effect upon its passage.

[Approved by the Governor, March 12, 1902.]

W. MURRAY CRANE.

CONSTITUTION AND BY-LAWS

PREAMBLE

The members of the Boston Society of Civil Engineers, in accordance with their charter and for the more effectual execution of the design of their institution, establish and ordain the following Constitution and By-Laws for the government of said Society.

CONSTITUTION

ADOPTED JUNE 15, 1910 *

ARTICLE I — OBJECTS

The objects of this Society are: the professional improvement of its members, the encouragement of social intercourse among engineers and men of practical science, and the advancement of engineering. For the promotion of these objects, stated meetings of the Society shall be held and a library maintained for the use of its members.

ARTICLE II — MEMBERSHIP

The Society shall consist of Members, Honorary Members, Juniors, Students and Associates.

Members shall be civil, mechanical, mining or electrical engineers, or other persons belonging to a technical profession, not less than twenty-four years of age, who have been in the active practice of their profession for at least four years. Graduation from a school of engineering of recognized standing shall be considered as equivalent to two years of active practice.

Honorary Members shall be men of eminent scientific attainments whom the Society shall deem worthy of the distinction. They shall be subject to the payment of no fees, dues or assessments.

Juniors shall be not less than eighteen years nor more than twenty-five years of age, and their connection with the Society shall cease when they become twenty-six years of age, unless they be previously transferred to another grade. They shall be in active practice in some branch of engineering, or other technical profession, or graduates from a school of engineering of recognized standing. Students shall be students in a school of engineering of recognized standing. Their membership shall cease at the annual meeting following the severance of their connection as students, unless they shall have transferred to another grade of membership.

* Amended May 18, 1932, in Article II.

Other persons interested in the objects of the Society and desirous of being connected with it shall be eligible as Associates.

The members of all grades shall be entitled to all privileges of the Society except the right to vote and to hold office, which rights shall be vested in the grade of Member alone; provided, however, that such Members as may be elected Honorary Members shall retain the right to vote and to hold office.

ARTICLE III — OFFICERS

The officers of the Society shall consist of a President, two Vice-Presidents, a Secretary, a Treasurer and four Directors. They shall be elected by letter-ballot at the Annual Meeting; shall assume their duties at the close of said meeting, and shall hold office until their successors are duly chosen. The President, Secretary and Treasurer shall be elected for one year; the Vice-Presidents and Directors for two years, one Vice-President and two Directors being elected each year.

The officers with the three latest Past Presidents who continue to be Members of the Society shall constitute the Board of Government, which shall have general management of the affairs of the Society.

ARTICLE IV — MEETINGS — QUORUM

Meetings of the Society shall be held at such times as may be prescribed by the By-Laws.

The regular meeting in March shall be the Annual Meeting for the election of officers and for the hearing of the annual reports.

Twenty-five members shall constitute a quorum for the transaction of business.

ARTICLE V — AMENDMENTS — ENDORSEMENTS

Proposed amendments to this Constitution shall be first submitted in writing to the Secretary, endorsed by at least five Members of the Society. The Board of Government shall designate some subsequent regular meeting, not later than four months from the date of the receipt of the petition, for discussion or amendment of the proposed amendment and shall so signify in the notice for said meeting. This notice shall contain a copy of the proposed amendment. If the proposed amendment, in its original or amended form, shall be adopted by a majority of the Members present and voting, it shall be forthwith submitted as adopted, in the form of a letter-ballot, to the Members for final action. The letter-ballot shall be accompanied by a notice of the date of the meeting at which the ballot will be canvassed, which date shall be not less than three weeks later than the date of its issue. An affirmative vote of two-thirds of all ballots cast shall be necessary to the adoption of any amendment.

No proposition which includes the Society's endorsement shall be passed except in the same manner as prescribed for amendments to the Constitution.

BY-LAWS

ADOPTED JUNE 15, 1910 *

1. Meetings. — Regular meetings of the Society shall be held on the fourth Wednesday in January and September and on the third Wednesday of the other months, excepting July and August, unless otherwise authorized by the Board of Government.

2. Order of Business. — The following order of business shall be observed at all regular meetings unless set aside by a vote of members present: —

(1) Reading of the record of the previous meeting.

(2) Business and reports of committees.

(3) Literary exercises, to begin not more than a half-hour after the meeting is called to order.

(4) Unfinished business.

3. Special Meetings. — The President may call meetings of the Society when he deems it expedient, and shall do so at the written request of ten Members, stating the purpose of such meeting. No business shall be transacted at a special meeting except that stated in the notice thereof.

4. Expiration of Committees. — At the Annual Meeting all special committees shall expire unless continued by a vote of the Society.

5. Nominating Committee and Election of Officers. — Whenever officers of the Society are to be elected by ballot, nominations shall be made by a Nominating Committee of nine, of whom three shall be the three latest Past Presidents who continue to be members of the Society and are not members of the Board of Government, and six shall be elected by ballot. Three members of the Nominating Committee shall be elected at each annual meeting to serve two years each.

The Nominating Committee shall organize and act under its own rules. It may make nominations whether at the time it consists of nine members or of less, but the approval of at least six members of the Nominating Committee shall be required for a nomination.

The Nominating Committee shall prepare a list of its nominations for the officers to be elected at the annual election, and the Secretary shall mail this list to each member of the Society at least nine weeks before the annual meeting. An additional nomination for any office may be made by any twenty-five members of the Society who sign a nomination paper to that effect and file it with the Secretary at least six weeks before the date of the annual meeting. The Secretary shall print no nomination on any list or ballot until he has received notice in writing that the nomination is made with the knowledge and consent of the nominee. At least four weeks before the day of the annual meeting, letter-ballots shall be sent by the

* Amended March 19, 1913; Jan. 28, 1914; Dec. 19, 1917; June 15, 1921; Feb. 21, 1923; Nov. 18, 1925; Jan. 26, 1927; Oct. 17, 1928; Sept. 24, 1930; and May 18, 1932.

Secretary to each member of the Society, bearing the nominations made by the Nominating Committee, and also any which have been received on nomination papers as above provided, which latter nominations shall be distinguished in some convenient way from those made by the Nominating Committee. The ballot shall state the hour at which polls will close on the day of the annual meeting.

When returned to the Secretary, each ballot shall be enclosed in two envelopes, the inner one to be blank, and the outer one to be endorsed by the member's signature. The President shall appoint two tellers who shall canvass all ballots, and the result shall be announced at the annual meeting.

Of the candidates for any office at the election at the annual meeting, the one having the largest number of legal votes by letter-ballot shall be elected. Should there be a failure to elect any officer on account of a tie, the meeting shall proceed to elect such officer by ballot from among the candidates so tied, a majority of the votes cast being required to elect.

At any meeting of the Society, a vacancy for the unexpired term of an elected officer or a member of the Nominating Committee may be filled by ballot, provided the Nominating Committee gives notice in the call for the meeting of its nomination or nominations for such vacancy, a majority of the votes cast at the meeting being necessary to elect.

Whenever a President, Vice-President, Director, Secretary or Treasurer is to be elected, the Nominating Committee shall nominate one candidate for each office to be filled. Whenever a member of the Nominating Committee is to be elected, the Nominating Committee shall nominate two candidates for each office which is to be filled. Ballots shall provide space for the writing or pasting in of additional names by the voters.

Vacancies occurring in any office may be filled by ballot at the first meeting after notice of the same has been sent to each Member, a majority of the votes cast being necessary to elect.

6. Duties of Officers. — The President shall have general supervision of the affairs of the Society. He shall preside at all meetings of the Society and of the Board of Government at which he may be present. He shall deliver an address at the Annual Meeting.

The Vice-Presidents in order of seniority shall preside at meetings in the absence of the President and discharge his duties in case of a vacancy in the office.

The Secretary, under the direction of the President and Board of Government, shall be the executive officer of the Society. He shall keep records of all meetings of the Society and of the Board of Government; shall receive all fees, dues and other moneys due the Society (except the income on the permanent fund) and transmit the same monthly to the Treasurer.

The Treasurer, under the direction of the President and Board of Government, shall be charged with the custody and investment of all funds of the Society, and shall file annually an approved surety bond in an amount to be determined by the Board of Government, the premium on said bond to be paid from the Society's funds. He shall receive all funds transmitted by the Secretary and shall

pay all bills or other indebtedness of the Society when properly approved by the President. He shall keep an accurate record of all receipts and disbursements and of all property of the Society in his charge and shall render a report of same at the Annual Meeting.

A committee consisting of two Directors, to be appointed by the President, shall audit the accounts of the Secretary and Treasurer.

The Board of Government shall have general management of the affairs of the Society in conformity with the Constitution and By-Laws. It shall hold stated meetings at least once in every month, excepting July and August, and at such other times as it may determine or when called by the President. Five members shall constitute a quorum for the transaction of business. The Board of Government shall direct the investment and care of the funds of the Society; shall order all ordinary or current expenditures; shall fix the salaries of the Secretary, Treasurer and Librarian; shall provide for the exercises at the meetings; shall act upon applications for membership as hereinafter provided; shall examine all papers submitted with reference to their fitness for presentation to the Society and for publication, and shall report at each Annual Meeting. To perform these duties it may make such rules and regulations, within its powers, as it may deem necessary; and may appoint committees from its members and delegate to them such of its powers as it may deem expedient, provided, however, that any action of a committee unfavorable to any member shall be reported to the whole Board for final action. The Board of Government shall appoint from its members, or from the members of the Society at large, a Committee on Publication, which shall have charge of the publication of all papers and transactions of the Society.

The Board of Government shall elect each year a member of the Society as Librarian, who shall have the general supervision of the Society's library, shall make recommendations to the Board of Government relating thereto, and shall, under its direction, expend such sums as may be appropriated for the library.

7. Election of Members. — Honorary Members shall be proposed by at least ten Members and shall be elected by a unanimous vote of the Board of Government. A person elected an Honorary Member shall be promptly notified thereof by letter. The election shall be cancelled if an acceptance is not received within six months after the mailing of such notice.

An application for admission to the Society as a Member, Junior or Associate, or for transfer from one grade to another, shall contain over the candidate's signature, a statement of his age, residence and qualifications for membership, and a promise that he will conform to the requirements of membership, if elected. The applicant shall furnish the names of at least four members to whom he is personally known. Each of these shall be requested by the Secretary to address a letter to the Board of Government, on a form prescribed by said Board, stating the extent of the writer's personal knowledge of the applicant and of his professional work. If less than four of the members named as references furnish the requisite information the Secretary shall call upon the applicant for additional names, and not until written communications shall have been received from at least four members shall the application be considered by the Board. Applicants

who may be so situated as not to be personally known to four members may be recommended by three members of the Board of Government.

Each application for admission or for transfer shall be announced in the JOURNAL, accompanied by a concise statement of the record of each applicant and the names of his references, together with a request that members transmit to the Board any information in their possession which may be of assistance in the consideration of the application. Not less than fifteen days after said announcement, the Board of Government shall consider the application together with any information in regard to the applicant that may have been received; shall classify the applicant with his consent and shall vote thereon. At least nine votes shall be cast to constitute an election, these votes to be cast by letter-ballot if necessary. Two or more negative votes shall exclude from election.

Each elected candidate shall be duly notified and shall subscribe to the Constitution and By-Laws and pay his entrance fee. If these provisions are not complied with within two months from the notification of the election, such election shall be void unless, for special reasons, the time shall be extended by the Board of Government. Membership of any person shall date from the day of his election.

A rejected applicant may renew his application for membership or transfer at any time after the expiration of one year from the date of the ballot rejecting his previous application.

An applicant for Student Membership shall submit a statement that he is a bona fide student in the Institution which he is attending. This statement shall be signed by the Dean, Registrar or other officer of the Institution acceptable to the Board of Government.

8. Fees and Dues. — The entrance fee for Members and Associates shall be ten dollars, and for Juniors, five dollars; a Junior transferred to the grade of Member or Associate shall pay an additional fee of five dollars. There shall be no entrance fee for Students. Students who transfer to another grade shall pay the entrance fee for that grade when the transfer is made. The annual dues, payable in advance at the Annual Meeting, shall be as follows: by Resident Members and Associates, ten dollars; by Non-Resident Members and Associates, six dollars; by Resident Juniors, five dollars; by Non-Resident Juniors, four dollars; and by Students, three dollars, for a full year or fraction thereof. The members of any grade residing within thirty miles of Boston shall be considered as Resident, and those beyond that limit as Non-Resident. New members elected during the period from the close of the annual meeting to June inclusive shall pay full year's dues; members elected during the period from July to December inclusive shall pay one-half year's dues for that fiscal year; members elected during the period from January to the annual meeting inclusive shall be exempt from dues during the remainder of that fiscal year. The fiscal year shall commence at the close of the annual meeting.

Three dollars of the dues of each member, or such portion thereof as may be required, shall annually be applied to the payment of a subscription to the JOURNAL of the Boston Society of Civil Engineers.

The Board of Government may for such reasons as it may deem sufficient

remit the dues in any current year of any member whom it may find to be unable to pay the same, no record to be made of the name of such member, but the number of such cases shall be reported to the Society annually.

A member of any grade who has paid dues for forty years, or who has reached the age of seventy years and has paid dues for thirty years, shall be exempt from further dues.

9. Permanent Fund. — There shall be a fund called the Permanent Fund, to which shall be added all money received for entrance fees and all income from investments of the fund. No money shall be appropriated from the fund except by a two-thirds vote at two successive regular meetings. Any such appropriation or any part thereof not used within three years shall be returned to the fund.

10. Resignation of Membership. — Any person whose indebtedness to the Society has been fully paid may withdraw from membership by notifying the Secretary. Any person so resigning his membership may, at the discretion of the Board of Government, be reinstated without again paying the entrance fee.

11. Forfeiture of Membership. — Ten months after the Annual Meeting, the Secretary shall notify each member who has not paid his dues for the current year, that unless same are paid within thirty days, his membership in the Society shall cease. Unless said payment is so made his name shall be dropped from the list of members. The Board of Government may, however, at its discretion, reinstate such person on the payment of all arrears.

12. Expulsion of Members. — Upon the written request of five Members, that, for cause stated, any member be expelled, the Board of Government shall consider the matter, and if it deems it best, shall advise the member that his resignation will be accepted. He shall, however, have the right to demand and receive a copy of the charges against him, and shall have reasonable time to present a written defence. The Board of Government may then pass finally upon the matter; and if the resignation has not been tendered, or a satisfactory defence made, may, by an affirmative vote of nine of its number, expel the member, in which case he shall be notified, and his name shall at once be dropped from the list of members.

13. Sections. — The Board of Government may from time to time at its discretion, establish sections for the consideration of special branches of engineering. Such sections shall in all cases be known as "The [name] Section of the Boston Society of Civil Engineers," and shall consist of not less than ten members of the Society.

Unless a section is in active operation within three months from the date of its establishment, the authorization for its formation shall be void.

Members of the Sanitary Section who are not members of the Society at the time of the adoption of these By-Laws, may continue their present membership by the annual payment of six dollars for dues; they may be transferred to membership in the Society in the same manner and by the payment of the same fee as provided for the transfer of Juniors. This paragraph shall be void when the list of members to which it applies has been exhausted.

Papers read before sections and discussions thereon may be reported in ac-

cordance with the section by-laws, and shall be published in the same manner and subject to the same conditions as obtain with respect to papers read before the Society.

All sections shall be governed by the Constitution and By-Laws of the Society, so far as applicable, but they shall be entitled to make additional by-laws for their own use and government; *provided, however*, that said additional by-laws be not inconsistent with the Constitution and By-Laws of the Society, and that they be approved by the Board of Government.

The officers of each section shall be a Chairman, Vice-Chairman and Clerk, who shall be elected by the members of the section annually.

The general government of each section shall be vested in an Executive Committee, consisting of the President of the Society, the officers of the section, and three additional members of the section who shall be elected annually.

The officers of sections may expend such sums for the expenses of meetings as may be appropriated by the Board of Government.

The Chairmen of sections shall be entitled to be present at the meetings of the Board of Government, but shall have no vote.

Any section may be abolished by the Society by a two-thirds vote of all the Members present at any regular meeting, upon recommendation of the Board of Government, due notice of such recommendation having been sent with the notice of the meeting to each Member of the Society, and to each member of the section in question who is not a member of the Society; and all members of the section in question shall be entitled to be heard at this meeting.

Resignations, forfeiture of membership, or expulsion of members of sections shall be governed by the same conditions and methods of procedure as apply to members of the Society.

14. Affiliate Sections. — The Board of Government may, from time to time, at its discretion, establish Affiliate Sections which shall be duly organized sections of kindred societies whose objects are in harmony with those of this Society. The requirements governing such Affiliate Sections shall be those governing Sections, as provided for under these By-Laws so far as applicable, with such modification as may be approved by the Board of Government as necessary to effect suitable working arrangements, having due regard to the interests of this Society.

15. An amendment to the By-Laws may be made by a two-thirds vote of the Members present and voting, cast in favor of such amendment at each of two successive regular meetings, due notice of the proposed amendment having been sent to each Member with the notices of the meetings.

BY-LAWS OF THE SECTIONS

Adopted by the Sanitary Section, Designers Section, Northeastern University
Section and Highway Section

(Approved by the Board of Government March 21, 1934)

ARTICLE I — OBJECTS

SECTION 1. The objects of the Section shall be the advancement of knowledge relating to the science and practice of engineering, the professional improvement of its members, the encouragement of the presentation of papers and informal discussion of engineering topics, and the opportunity for social intercourse among its members.

ARTICLE II — MEMBERSHIP

SECTION 1. Members of the Boston Society of Civil Engineers in all grades shall be entitled to membership in the Section upon making written application to the Executive Committee of the Section, except as follows: Membership in the Northeastern University Section is limited to members of the Society in all grades, who are students, graduates or members of the Faculty of Northeastern University.

SECTION 2. Eligibility to office and the right to vote shall be limited to the membership of the Section, except as follows: Only those members of the Northeastern University Section who are students at Northeastern University are eligible to hold office in that section.

SECTION 3. Members of the Society in all grades, who are not enrolled as members of the Section, shall be entitled to attend all meetings of the Section and take part in the discussion of professional subjects, but shall have no vote.

ARTICLE III — OFFICERS

SECTION 1. The officers of the Section shall be a Chairman, Vice-Chairman and Clerk. The general government of the Section shall be vested in an Executive Committee, consisting of the President of the Boston Society of Civil Engineers, the Chairman, Vice-Chairman, Clerk and three other members of the Section.

SECTION 2. The Chairman of the Section shall represent the Section at the meetings of the Board of Government of the Boston Society of Civil Engineers, with the privilege accorded under its By-Laws.

SECTION 3. The term of office of all officers and committees shall be one year, but shall continue until their successors are elected.

SECTION 4. All officers and committees shall assume their duties immediately after the close of the meeting at which they have been elected.

SECTION 5. Vacancies occurring in any office may be filled by ballot at the first meeting after notice of the same has been sent to each member, a majority of the votes cast being necessary to elect.

ARTICLE IV — MANAGEMENT

SECTION 1. The Chairman shall have general supervision of the affairs of the Section. He shall preside at meetings of the Section. In case of his absence or a vacancy in his office, the Vice-Chairman shall discharge his duties.

SECTION 2. The Executive Committee shall have control of the management of the Section, subject to the action of the Section at any meeting, and shall make the necessary arrangements for all meetings. All questions in Executive Committee shall be decided by a majority vote, and four members shall constitute a quorum. Meetings of the Executive Committee shall be held at the call of the Chairman, or, in his absence or inability to serve, at the call of the Vice-Chairman.

SECTION 3. The Clerk shall keep the records of the meetings of the Section and of the Executive Committee, and perform such other duties as are herein prescribed and as may be required by the Executive Committee. He shall prepare and transmit to the Secretary of the Boston Society of Civil Engineers notices of all meetings, copies of the records of all meetings and of all papers and discussions.

SECTION 4. No expenditure shall be made or financial obligation incurred by any officer or committee of the Section, for which the Society will be responsible, without previous authorization by the Board of Government or President of the Society.

ARTICLE V — MEETINGS

SECTION 1. The annual meeting of the Section, at which the annual reports for the preceding year shall be presented and the officers for the ensuing year elected, shall be held as follows:

Sanitary Section. — First Wednesday in March.

Designers Section. — Second Wednesday in March.

Northeastern University Section. — Fourth Thursday of the last five-week period of the spring term.

Highway Section. — Fourth Wednesday in February.

SECTION 2. The officers and other members of the Executive Committee shall be elected at this meeting by written ballot. A Nominating Committee of three members, which shall be elected at a meeting in advance of the Annual Meeting, shall present a list of nominees for officers and other members of the Executive Committee at the Annual Meeting. Additional nominations may be made from the floor.

SECTION 3. The regular meetings of the Section shall be held as follows, unless otherwise authorized by the Executive Committee:

Sanitary Section. — First Wednesday of the months of March, June, October and December.

Designers Section. — Second Wednesday of the months of October to May, inclusive.

Northeastern University Section. — Fourth Thursday of every five-week school period.

Highway Section. — Third Wednesday in September; fourth Wednesday of the months of November, February and April.

SECTION 4. Special meetings of the Section shall be held at the call of the Chairman. At special meetings no business shall be transacted, unless announced in the call for the meeting and upon recommendation of the Executive Committee.

SECTION 5. Ten members shall constitute a quorum for the transaction of business.

ARTICLE VI — AMENDMENTS

SECTION 1. Proposed amendments to these By-Laws must be submitted in writing to the Executive Committee, and shall be presented to the Section at a regular meeting, if so decided by vote of the Executive Committee. The Executive Committee shall, however, bring before the Section any proposed amendment at the written request of ten members.

SECTION 2. Announcement of a proposed amendment which is recommended by the Executive Committee or by ten members of the Section shall be given by printing the amendment in the notice of the regular meeting. A two-thirds vote of the members present and voting shall be necessary for the adoption of the amendment.

SECTION 3. All amendments to these By-Laws must receive the approval of the Board of Government of the Boston Society of Civil Engineers before taking effect.

PRIZES AWARDED BY BOSTON SOCIETY OF CIVIL ENGINEERS

DESMOND FITZGERALD MEDAL

THE Desmond FitzGerald medal, an endowed prize, is awarded for papers presented at meetings of the Boston Society of Civil Engineers and published in the JOURNAL of the Society. This prize is to be awarded annually unless the Board of Government shall decide that none of the papers presented during the year are of such a character as to merit the award.

With the assent and approval of the donor, the Society has assumed the responsibility for the payment in perpetuity of the Desmond FitzGerald medal.

Rules Governing the Award of the Desmond FitzGerald Medal

COMMITTEE ON AWARD

1. The Board of Government shall appoint annually, not later than its regular meeting in June of each year, three members of the Society, not members of the Board of Government, who shall form a committee to recommend the award of the prize.

2. The papers considered shall include all papers published by the Society during the year ending with the month of January.

3. The Committee on Award shall report its recommendation to the Board of Government at its February meeting, and the awards shall be made by the Board of Government.

4. The announcement of the awards shall be made at the annual meeting.

5. The Secretary of the Society shall act as Secretary to the Committee on Award, but shall have no vote or voice in its deliberations.

CODE OF RULES

THE DESMOND FITZGERALD MEDAL. — This medal was instituted and endowed in 1910 by Desmond FitzGerald, member and Past President of the Boston Society of Civil Engineers.

I. Competition for the medal of the Boston Society of Civil Engineers shall be restricted to members of the Society of all grades.

II. There shall be one bronze medal awarded as hereinafter provided. The dies therefor shall be deposited with the superintendent of the United States Mint at Philadelphia, in trust exclusively for the above purpose.

III. All original papers presented to the Society by members of any class, and published by the Society during the year for which the medal is awarded, shall be open to the award, provided that such papers shall not have been previously contributed in whole or in part to any other association, nor have appeared in print prior to their publication by the Society.

IV. The medal shall be awarded for a paper which shall be judged worthy of special commendation for its merit.

SECTION PRIZE AWARDS

Sections of Boston Society of Civil Engineers

Sanitary Section, organized in 1904.

Designers Section, organized in 1920.

Highway Section, organized in 1924.

Northeastern University Section, organized in 1922.

Rules Governing Section Awards for Sanitary, Designers and Highway Sections

The Board of Government of the Boston Society of Civil Engineers voted on April 12, 1924, "to present a prize for a worthy paper given in each section by a member of that Section," the awards to be made under the following rules:

1. The Board of Government shall award annually in each section a prize for the best paper presented during the year, provided that paper is judged worthy of special commendation.

2. The Board shall appoint annually a Committee on Award for each section, to be composed of three members, one of whom shall be a member of the Committee on Award of the Desmond FitzGerald medal, the others shall be members of the particular section involved, and none shall be members of the Board of Government. The appointment shall be made not later than at its regular meeting in June. The Committee on Award shall recommend to the Board their selection of successful papers.

3. The papers considered shall include all original papers which are submitted in form suitable for publication, by members in all grades of the respective sections, and shall have been accepted by the Executive Committee of the Section or its approved agent, either for publication or for presentation at a meeting. All papers considered shall be presented at a meeting or published during the year ending with the month of January, and no paper shall be eligible which has received, or is to receive, any other award of the Society, or which has previously been contributed to any other association, or has appeared in print prior to its presentation to the section.

4. The Committee on Award shall report their recommendations to the Board of Government at its February meeting, and the awards shall be made by the Board of Government.

5. The announcement of the awards shall be made at the annual meeting.

6. The award shall consist of a book or books of a value not exceeding fifteen dollars, and shall be suitably inscribed on the flyleaf with the name of the recipient, the name and date of presentation of the paper, and the name of the section, together with the fact that it was judged the most worthy paper presented in that section during that particular year. The inscription shall be in handwriting attested to by the President of the Society and the chairman of the Section. The Committee on Award shall select the book or books to be awarded, but may consult with the recipient as to his particular desires in the matter.

Rules Governing Prize Awards for Northeastern University Section

The Board of Government voted on March 10, 1931, to revise the Rules Governing the Award of Section Prizes in order to provide specifically for the award of a prize to a member of the Northeastern University Section.

1. The Board of Government of the Boston Society of Civil Engineers shall award annually in the Northeastern University Section a prize for an original paper prepared by a member of the Section and presented by the author during the year at a regular Engineering Conference meeting.

2. A committee of the faculty at Northeastern University shall present to the Committee on Award of the Boston Society of Civil Engineers two papers selected by the University at such a time as may be required.

3. The Committee on Award shall report its recommendation to the Board of Government at its February meeting, and the awards shall be made by the Board of Government.

4. The announcement of the awards shall be made at the annual meeting of the Boston Society of Civil Engineers.

5. The award shall consist of a book or books of a value not exceeding fifteen dollars; these shall be suitably inscribed with the name of the recipient, the name and date of publication of the paper, and the name of the Section, together with the fact that it was judged a paper worthy of special commendation. The inscription shall be signed by the President of the Society and the chairman of the Section. The Committee on Award shall select the book or books to be awarded, but may consult with the recipient as to his particular desires in the matter.

6. The winning paper may or may not be printed in the JOURNAL of the Boston Society of Civil Engineers at the discretion of the Publication Committee.

CLEMENS HERSCHEL AWARDS

In 1923 the late Clemens Herschel, a Past President and an honorary member of the Boston Society of Civil Engineers, presented to the Society a number of autographed copies of his book, entitled "Frontinus and the Water Supply of the City of Rome," with the request that the Board of Government should award one or more of these books as prizes for papers which have been particularly useful and commendable and worthy of grateful acknowledgment.

OF GENERAL INTEREST

PRIZES AWARDED AT ANNUAL MEETING OF THE BOSTON SOCIETY OF CIVIL ENGINEERS, MARCH 21, 1934

The Desmond FitzGerald Medal

Presentation made by Albert Haertlein, Member of the Committee on Award

A committee consisting of Past President Frank M. Gunby, Prof. Thomas R. Camp and myself, as chairman, reviewed the papers which were published in the JOURNAL of the Boston Society of Civil Engineers during the past year for the purpose of selecting the one which in the opinion of the committee should be awarded the Desmond FitzGerald Medal. The paper entitled "The Design and Construction of the French King Bridge on the Mohawk Trail Route Across the Connecticut River, Massachusetts," by Albert E. Kleinert, Member, was recommended to the Board of Government. This paper was presented at a meeting of the Society held on April 18, 1933, and was pub-

lished in the JOURNAL of the Society for June, 1933.

The Desmond FitzGerald Medal was instituted and endowed in 1910. This, the twentieth award, is the first time it has been awarded to a paper describing a whole bridge. Mr. Desmond FitzGerald would be particularly pleased to see the award made for a description of the engineering problems of a structure which was considered the most beautiful bridge of its class built during 1932. Mr. FitzGerald was a great lover of art as well as an excellent engineer.

On behalf of the Board of Government, I take pleasure in presenting the Desmond FitzGerald Medal to Mr. Albert E. Kleinert.

The Clemens Herschel Prize

Presentation made by Vice-President, John B. Babcock, 3d

Clemens Herschel, the donor of this prize, had been a member of the Society for fifty-six years at the time of his death on March 1, 1930. He was one of that group of fifty engineers who took part in the resuscitation of the Society on June 8, 1874, after its temporary lapse of activities following the period of the Civil War. Mr. Herschel

served as Treasurer from 1874 to 1880' was President for the year 1890-91' and became an honorary member in 1915. Although living in New York City for the last forty years of his life, his interest in the Society never flagged. He was a constant contributor to our library and established the Herschel Library, a special section devoted

almost exclusively to non-technical books written by engineers, and to books about engineers.

Several years ago he sent to the Society a few autographed copies of his book "Frontinus and the Water Supply of the City of Rome," with the request that one or more copies be presented each year for papers which "*have been particularly useful and commendable and worthy of grateful acknowledgment.*" Upon his death he left his library to the Society, as well as a substantial bequest for the perpetuation of an award in such manner as the government of the Society should determine.

To a civil engineer the name of Herschel is, of course, associated with hydraulics, the field in which he became so eminent. The "Venturi" meter was developed by Clemens Herschel, although with characteristic modesty he named it after Giovanni Battista Venturi (1746-1822), an ordained priest and professor of experimental physics at the University of Modena, who a century earlier had experimented with the diverging tube. For many years Herschel had been intensely interested in the subject of ancient water supplies and in the early methods of measuring the flow of water. As a result of this interest, he translated from the Latin the two books on

"The Water Supply of the City of Rome" of Sextus Julius Frontinus, Water Commissioner of the city of Rome, A.D. 97. The volume as published by Clemens Herschel includes the photographic reproduction of the Montecassino manuscript, the Latin text, the translation into English, together with material of a descriptive nature by Herschel which makes this book most illuminating to the civil engineers of today. The presentation

of one of these unusual volumes tonight to an engineer who has done notable work in the field of hydraulics is particularly appropriate. It is a privilege to have the opportunity of presenting this prize which has been awarded by vote of the Board of Government of the Society to —

KARL R. KENNISON

Designing Engineer

Metropolitan District Water Supply
Commission

for his paper on a

"New Type Open-Nozzle for
Measurement of Sewage Flow"

Presented before the Sanitary Section
on December 6, 1933, and

Published in the January, 1934, JOURNAL.

The Sanitary Section Prize

*Presentation made by Prof. Thomas R. Camp, Chairman of Sanitary Section
Prize Award Committee*

The Sanitary Section Prize, an award provided by the Board of Government since 1924, is given for the best paper presented in this Section during the year by a member of the Section. The committee, consisting of Prof. Gordon M. Fair, Mr. Francis H. Kingsbury and the speaker, reviewed the papers presented and selected the one entitled —

"Sewer Assessment Practice in Massachusetts," by Paul F. Howard, Member, presented at a meeting of the Sanitary Section on March 1, 1933, and published in the September, 1933, JOURNAL. The prize consists of the book on "The Design and Construction of Dams," by Edward Wegmann, which I take pleasure in presenting to Mr. Howard.

The Designers Section Prize

Presentation made by Prof. Albert Haertlein, Chairman of Designers Section Prize Award Committee

The Committee on Designers Section Prize Award, consisting of Messrs. LeRoy M. Hersum, Kimball R. Garland and myself, as chairman, recommended to the Board of Government that the Designers Section Prize be awarded to Dr. John B. Wilbur for his paper entitled "A New Method for Analyzing Stresses due to Lateral Forces." The paper was presented at a meeting of the Designers Section on January 10, 1934,

and published in the JOURNAL of the Boston Society of Civil Engineers for January, 1934.

Dr. Wilbur chose a book by Müller-Breslau, which is published in Germany and was expected to arrive for this occasion. Although the book is not here, I take great pleasure in presenting the book plate, which is to be placed in the book, to Dr. John B. Wilbur.

EDWARD W. HOWE FUND

The Society has received recently the sum of \$1,000 as a bequest from the late Edward W. Howe, a former Past President of the Society. Mr. Howe's professional activities, as assistant civil engineer for the city of Boston, covered many undertakings of the city, including park construction and numerous bridges from 1874 to 1916. In 1874 he was one of those who took active part in the revival of the Boston Society of Civil Engineers, and always maintained an interest in the affairs of the Society. His gift was made without any specific

requirement as to its use, but at the annual meeting the Society held on March 21, 1934, it was —

Voted, (1) That the sum be maintained as a separate fund to be named and known as the Edward W. Howe Fund.

(2) That the principal be maintained intact.

(3) That the income from the Fund be appropriated by vote of the Board of Government and used for any worthy object for the benefit of the Society or its members.

PROCEEDINGS OF THE SOCIETY

MINUTES OF MEETINGS

Boston Society of Civil Engineers

FEBRUARY 14, 1934. — A regular meeting of the Boston Society of Civil Engineers was held this evening at the Institute of Geographic Explorations, Harvard University, and was called to order by the President, Arthur W. Dean. Two hun-

dred and ten members and guests were present.

The President stated that this meeting was held at this building through the courtesy of Harvard University and Dr. A. Hamilton Rice, Director of Geographic Explorations.

The President introduced Mr. Weld Arnold, Instructor, who briefly outlined the purpose of the building, and described

the equipment, instruments, library and laboratories contained in it, which were provided largely by Dr. Rice and which were to be opened for inspection by all present.

Mr. Weld Arnold then presented the speaker of the evening, Capt. Albert W. Stevens, lecturer on aero' photography at Harvard University and Head of the Experimental Photographic Division of the United States Army Air Corps at Wright Field, Dayton, Ohio.

Captain Stevens accompanied Dr. Rice and Mr. Arnold on the explorations of the Amazon River country in South America.

Captain Stevens' talk, "Methods and Progress in Aerial Photography for Map Making," described the instruments and cameras used in making aerial photographs for this purpose, and interwove accounts of aerial experiences in South America, long-range photographing, through the use of photographic processes designed to use the infra-red rays, and of photographic studies of the solar eclipse of 1932. Also he gave a description of the proposed balloon trip into the stratosphere planned for the coming summer. The talk was illustrated with lantern slides.

Following the talk open house was afforded all present to permit each to see the instruments used as well as other equipment, including radio towers on the roof, libraries, laboratories, instruments and maps.

The meeting adjourned at 10 o'clock.

EVERETT N. HUTCHINS, *Secretary*.

MARCH 21, 1934. — The eighty-sixth annual meeting of the Boston Society of Civil Engineers was held today at the Boston Chamber of Commerce and was called to order by the President, Arthur W. Dean, at 4.30 P.M.

The minutes of all previous meetings of the year which have been printed in various issues of the JOURNAL were declared approved as printed.

The President announced the death of the following members: Arthur C. Eaton, who died on March 6, 1934, and had been a member since May 16, 1917; John S.

Lamson, who died on March 8, 1934, and had been a member since May 19, 1915; Frank A. Garvin, who died August 7, 1933, and had been a member since April 2, 1928.

The Secretary reported that the following were elected to membership by the Board of Government on March 21, 1934:

Grade of Member: Walter M. Fife, George Augustus Graves, and Alexander P. Urban.

The President stated that a bequest of \$1,000 had been received on December 2, 1933, from the late Edward W. Howe, a former Past President of the Society, and that the Board of Government had accepted the gift and presented recommendations in regard to this gift.

Voted, (1) That the sum be maintained as a separate fund, to be named and known as the Edward W. Howe Fund.

(2) That the principal of the Fund be maintained intact.

(3) That the income from the Fund be appropriated by vote of the Board of Government and used for any worthy object for the benefit of the Society or its members.

The annual reports of the Board of Government, Treasurer, Secretary and Auditors were presented. Also reports were made by the following committees: Membership and Publicity, Social Activities, Relation of Sections to Main Society, Welfare, Library, Run-off, Subsoils of Boston, and Publication.

Voted, That the reports be accepted with thanks and placed on file, and that they be printed in the April, 1934, JOURNAL.

Voted, That the incoming Board of Government be authorized to appoint such committees as it deems desirable.

Mr. Charles T. Main, chairman of the John R. Freeman Fund Committee, stated that it was expected the income of the Freeman Fund would become available again for a scholarship or other use in accordance with the terms of the gift.

The report of the Tellers of Election, Charles W. Sherman and Gardner S. Gould, was presented, and in accordance therewith the President declared the following had been elected officers for the ensuing year:

President — Arthur T. Safford.
 Vice-President (for two years) — Arthur D. Weston.
 Secretary — Everett N. Hutchins.
 Treasurer — Karl R. Kennison.
 Directors (for two years) — Frank B. Walker, Samuel P. Waldron.
 Members of Nominating Committee (for two years) — Edward S. Averell, Kenneth C. Reynolds and Frederic N. Weaver.

The President then introduced the newly elected President, Arthur T. Safford. The other officers elected were asked to rise as their names were read.

The retiring President then delivered his annual address on "One Factor of Highway Transport."

This was illustrated with stereopticon and motion pictures.

On motion of Mr. Ralph W. Horne —

Voted, That the Society express its appreciation to the retiring President for his successful and economical administration of the affairs of the Society during the past year.

The meeting adjourned to reassemble at 7.30 P.M., the annual dinner being held during the interim.

The President then called the meeting to order for the presentation of prizes.

He requested Prof. Albert Haertlein, Chairman of the committee on Award of the Desmond FitzGerald Prize, to present the Desmond FitzGerald Medal to Albert E. Kleinert for his paper on "The Design and Construction of the French King Bridge on the Mohawk Trail Route Across the Connecticut River in Massachusetts," presented at a meeting of the Society on April 18, 1933, and published in the June, 1933, *JOURNAL*.

The President called upon Prof. Thomas R. Camp, chairman of the Sanitary Section Prize Award Committee, to present the Sanitary Section prize, consisting of a book suitably inscribed, to Paul F. Howard, for his paper on "Sewer Assessment Practice in Massachusetts," given at a meeting of the Sanitary Section on March 1, 1933, and published in the September, 1933, *JOURNAL*.

The President requested Prof. Albert Haertlein, Chairman of the Designers Section Prize Award Committee, to present the Designers Section prize to Dr. John B.

Wilbur for his paper on "A New Method for Analyzing Stresses Due to Lateral Forces in Building Frames," given at a meeting of the Designers Section on January 10, 1934, and published in the January, 1934, *JOURNAL*.

The President called upon Vice-President John B. Babcock, in representing the Board of Government, to present the Clemens Herschel prize, an autographed copy of the book entitled "Frontinus and the Water Supply of the City of Rome," written by the late Clemens Herschel, to Karl R. Kennison for his paper on "New Type Open-Nozzle for Measurement of Sewage Flow," given at a meeting of the Sanitary Section on December 6, 1933, and published in the January, 1934, *JOURNAL*.

The President announced that the Board of Government elected two honorary members on February 21, 1934, as follows: Harrison Prescott Eddy, who had been a member since February 17, 1904, and Joseph Ruggles Worcester, who had been a member since November 17, 1886. The newly elected honorary members were presented by the President with framed diplomas of membership. Previous to these presentations Prof. H. K. Barrows read a biographical sketch of Mr. Harrison P. Eddy, and Mr. Charles R. Main read a biographical sketch of Mr. Joseph R. Worcester. Each of these honorary members responded fittingly in accepting the honor.

The diplomas presented read as follows:

In recognition of his great attainments and of his many useful accomplishments as an engineer and an author —

HARRISON PRESCOTT EDDY

has been duly elected an

Honorary Member
of the

Boston Society of Civil Engineers

By direction of the Board of Government
February 21, 1934

(SEAL) ARTHUR W. DEAN,
President.
EVERETT N. HUTCHINS,
Secretary.

In recognition of his great attainments as an engineer, investigator and designer —

JOSEPH RUGGLES WORCESTER

has been duly elected an
Honorary Member
of the

Boston Society of Civil Engineers

By direction of the Board of Government
February 21, 1934

(SEAL) ARTHUR W. DEAN,
President.

EVERETT N. HUTCHINS,
Secretary.

A pleasing program of magic, humorous sketches and musical features concluded the program.

The President expressed his appreciation of the honor of serving as President of this Society and turned the affairs of the Society over to his successor, Mr. Arthur T. Safford.

One hundred and thirteen members and guests attended the dinner.

The meeting adjourned at 9.50 P.M.
EVERETT N. HUTCHINS, *Secretary.*

Designers Section

MARCH 14, 1934. — The annual meeting of the Designers Section of the Boston Society of Civil Engineers was held on

March 14, 1934, at the Society rooms, 715 Tremont Temple. Chairman F. W. Weaver called the meeting to order at 6 P.M.

The minutes of the January meeting and the annual report of the Executive Committee were read and accepted. The chairman read the proposed form of By-Laws for all the Sections of the Society.

Voted, That the proposed form of By-Laws be adopted by the Designers Section.

Mr. Ropes read the report of the Nominating Committee. The chairman called for additional nominations.

Voted, That the nominations be closed and that the Clerk be instructed to cast one ballot for the slate as read.

The new officers for the coming year are as follows:

Chairman — W. W. Bigelow.
Vice-Chairman — Henry Brask.
Clerk — Albert Haertlein.
Executive Committee — J. R. Nichols,
Mark Linenthal, A. S. Coombs.

Mr. Albert B. Rich gave a paper on "Stresses in Unsymmetrical Masonry and Composite Members, Subjected to Direct Stress and Oblique Bending." A short discussion followed.

There were twenty-seven members and guests present.

ALBERT HAERTLEIN, *Clerk.*

ANNUAL REPORTS

Report of the Board of Government for the Year 1933-34

BOSTON, MASS., March 21, 1934.

To the Boston Society of Civil Engineers:

Pursuant to the requirements of the By-Laws, the Board of Government presents its report for the year ending March 21, 1934.

Membership

Six new members, 3 juniors and 11 students have been added during the year, and 2 juniors have been reinstated, making a total addition of 22. Two juniors have been transferred to the grade of member, and 2 members have been elected to honorary membership. The total additions have been 22 members.

During the year 13 members have died, 29 have resigned, 4 have forfeited membership for non-payment of dues, making the total deductions 46.

The present membership of the Society consists of 5 honorary members, 734 members, 152 juniors, 16 associates, 1 member of the Sanitary Section only, and 54 student members, making a total membership of 962, a net loss for the year of 24.

The honorary membership list now is as follows:

Charles T. Main, elected January 28, 1932.
Dr. Karl T. Compton, elected February 17, 1932.
Prof. C. Frank Allen, elected March 16, 1932.
Harrison P. Eddy, elected February 21, 1934.
Joseph R. Worcester, elected February 21, 1934.

Deaths

William J. Alcott, Jr., October 20, 1933.
J. Edgar Borden, January 20, 1933.
Ernest W. Danforth, June 2, 1933.
Arthur Chester Eaton, March 6, 1934.
Benjamin W. Ellis, December 9, 1933.
Frank A. Garvin, August 7, 1933.
John S. Lamson, March 8, 1934.
John William Link, March 28, 1933.
Edward F. Miller, June 12, 1933.
Carroll C. O'Neill, September 13, 1933.
Louis K. Rourke, August 23, 1933.
J. Waldo Smith, October 14, 1933.
J. Parker Snow, September 4, 1933.

Remission of Dues

For members who have not paid the current year's dues the Board has remitted dues for 33 members and granted an extension of time to 101 other members. For members who owe two years' dues, *i.e.*, for years ending in March, 1933 and 1934, the Board has remitted dues for the year 1933 for 84 members, and granted to the same members an extension of time in which to pay the current year's dues. In summary, the Board has granted 117 remits and 185 extensions of time.

Exemption of Dues

Eighty-seven members are now exempt from dues in accordance with By-Law 8, which provided that "a member of any grade who has paid dues for forty years, or who has reached the age of seventy years and has paid dues for thirty years, shall be exempt from further dues.

Meetings of the Society

Nine regular meetings have been held during the year, and a joint outing with the New England Water Works Association on June 20, 1933, at the Presidential Country Club, Wayland.

The average attendance at the meetings of the Society was 127, the largest being 225 and the smallest 60. Buffet suppers have been a feature of all except one of the meetings. The papers and addresses given were as follows:

March 15, 1933. — Annual Meeting. Address of retiring President, Ralph W. Horne, "Observations Concerning our Economic Depression," followed by dinner, smoker and entertainment.

April 18, 1933. — "Design and Construction of the French King Bridge on the Mohawk Trail Route Across the Connecticut River, Massachusetts," by Albert E. Kleinert, Assistant Structural Engineer, Massachusetts Department of Public Works.

May 17, 1933. — "An Engineer's View of Taxation as Affecting the Economic Structure," by Lewis Jerome Johnson, Professor of Civil Engineering, Harvard Engineering School.

September 27, 1933. — "Earthquakes, Natural and Artificial," by Dr. L. Don Leet, Seismologist in charge of Seismograph Station at Oak Ridge Observatory of Harvard University.

October 18, 1933. — "New Tidewater Facilities of the Portland Terminal Company at Portland, Maine," by Asa H. Morrill, Assistant Chief Engineer, Boston & Maine Railroad and Maine Central Railroad, Portland, Maine.

November 15, 1933. — "Radio City, Rockefeller Center, New York," by Walter H. Kilham, Jr., Architect.

December 20, 1933. — "Steel Framing for Small Residences," by Frederick T. Llewellyn, Research Engineer, United States Steel Corporation.

January 24, 1934. — "The Cape Cod Canal and the new High Level Highway Bridges," a symposium; Lieut. Peter P. Goerz, United States Corps of Engineers, Rivers and Harbors, District Engineers Office, Boston, spoke on the "Canal and its Appurtenances;" Carroll A. Farwell, member of the firm of Fay, Spofford & Thorndike, spoke on "Design of the Highway Bridges across Cape Cod Canal;" Frank Andrews, Assistant Civil Engineer, Massachusetts Department of Public Works, described the "New Highway Approaches to the Bridges;" Francis L. Sellew, District Waterways Engineer, Massachusetts Department of Public Works, described the "New State Pier at Bourne."

February 14, 1934. — "Methods and Progress in Aerial Photography for Map Making," by Capt. Albert W. Stevens, Lecturer on Aero Photography at Harvard University and Head of the Experimental Photographic Division of the United States Army Air Corps at Wright Field, Dayton, Ohio.

Sections

Twenty meetings were held by the Sections of the Society during the year. These meetings of the Sections, offering opportunity for less formal discussion, have continued to demonstrate their value to their members and to the Society. The variety of subjects presented has made an appeal to the members, as indicated by the general attendance at these meetings.

Sanitary Section Meetings. — The Sanitary Section has held five meetings during the year, with an average attendance of 33. The papers and meetings are listed in the report of the executive committee. Present membership, 194.

Designers Section Meetings. — The Designers Section has held eight regular meetings during the year. The average attendance has been 56. The papers and meetings are listed in the report of the executive committee. Present membership, 177.

Highway Section Meetings. — The Highway Section has held three regular meetings during the year, with an average attendance of 36. Present membership, 102.

Northeastern University Section. — The Northeastern University Section has held four meetings during the year, with an average attendance of 22. Present membership, 223.

Journal

The complete report of the Editor of the JOURNAL for the calendar year 1933 will be printed in the April JOURNAL.

Funds of the Society*

Permanent Fund. — The Permanent Fund of the Society has a present value of about \$50,000. The Society again authorized the use of the current income of this fund, amounting to \$2,280, in payment of current expenses.

John R. Freeman Fund. — In 1925, the late John R. Freeman, a Past President and honorary member of the Society, made a gift of securities to the Society which was established as the John R. Freeman Fund, the present value of which is about \$26,000, and the income about \$1,600. The income from this fund is to be particularly devoted to the encouragement of young engineers. Mr. Freeman suggested several uses, such as the payment of expenses for experiments and compilations to be reported before the Society; for underwriting meritorious books or publications pertaining to hydraulic science or art; or a portion to be devoted to a yearly prize for the most useful paper relating to hydraulics contributed to this Society; or establishing a traveling scholarship every third year open to members of the Society for visiting engineering works, reports of which would be presented to the Society.

Lawrence DeFabritis completed in June, 1933, his year as holder of the scholarship. No further disbursements from the income of this fund have been made.

Edmund K. Turner Fund. — In 1916 the Society received 1,105 books from the library of the late Edmund K. Turner and a bequest of \$1,000, "the income of which is to be used for library purposes." The Board voted on February 21, 1934, to use as much of the income as necessary for permanent binding of volumes in the library.

Alexis H. French Fund. — The Alexis H. French Fund, a bequest amounting to \$1,000, was received in 1931 from the late Alexis H. French of Brookline, a former Past President of the Society. The income of this fund is "to be devoted to the library of the Society." None of the income of this fund has been used during the year.

* Details regarding the values and income of these funds are given in the Treasurer's report.

Desmond FitzGerald Fund.—The Desmond FitzGerald Fund, established as a bequest from the late Desmond FitzGerald, a Past President and honorary member of the Society, provides that the income from this fund shall "be used for charitable and educational purposes." The present value of the fund is about \$2,000. The board voted on January 24, 1934, to appropriate from the income of this fund the sum of \$100, to be known as the Boston Society of Civil Engineers Scholarship in memory of Desmond FitzGerald, to be given to a student at Northeastern University, and this will be presented to the selected student at a special meeting of the students to be held at an early date at the University.

Tinkham Memorial Fund.—The "Samuel E. Tinkham Fund," established in 1921 at the Massachusetts Institute of Technology by the Society "to assist some worthy student of high standing to continue his studies in civil engineering," had a value of \$2,527.33 on July 1, 1933. Mr. Anton E. Hittl of Melrose, Massachusetts, a student in civil engineering in the class of 1936 at Technology, has been awarded this scholarship for the year 1933-34.

Attention is called to the fact that the tuition at the Massachusetts Institute of Technology is now \$500 per year, whereas the annual income from the Tinkham Fund is about \$110. Additional donations for this fund would make it of greater service for the purpose for which it was established.

Clemens Herschel Fund.—This fund was established in 1931 by a bequest from the late Clemens Herschel, a former Past President and honorary member of the Society. The income from this fund is to be used for the presentation of prizes for particularly useful and commendable papers presented at meetings of the Society. The present value of this fund is about \$1,000.

Edward W. Howe Fund.—This fund, a bequest of \$1,000, was received December 2, 1933, from the late Edward W. Howe, a former Past President of the Society. No restrictions were placed upon the use of this money, but the recommendation of the Board of Government is that the fund be kept intact and that the income be used for the benefit of the Society or its members.

Desmond FitzGerald Medal

The Desmond FitzGerald medal (bronze) was provided for in 1910 as an endowed prize by the late Desmond FitzGerald, a former Past President and honorary member of the Society. This prize is awarded annually to a member who presents an original paper to the Society which is published in the JOURNAL for the current year.

In accordance with the recommendation of the Committee on Awards, the Board of Government voted to award the Desmond FitzGerald medal to Albert E. Kleinert, member, for his paper on "The Design and Construction of the French King Bridge on the Mohawk Trail Route across the Connecticut River, Massachusetts," presented at a meeting of the Society on April 18, 1933, and published in the JOURNAL of the Society for June, 1933.

Section Prizes

The Board of Government voted on April 12, 1924, "to present a prize for a worthy paper given in each section by a member of that section," this award to consist of books suitably inscribed.

Sanitary Section Prize.—The Board adopted the recommendation of the Special Committee on Section Prizes and voted on February 21, 1934, that the Sanitary Section Prize be awarded to Paul F. Howard, member, for his paper on "Sewer Assess-

ment Practice in Massachusetts," presented at a meeting of the Sanitary Section on March 1, 1933, and published in the September, 1933, JOURNAL.

Designers Section Prize. — The Board adopted the recommendation of the Special Committee on Section Prizes and voted on February 21, 1934, to award the Designers Section Prize to Dr. John B. Wilbur, member, for his paper on "A New Method for Analyzing Stresses due to Lateral Forces in Building Frames," presented at a meeting of the Designers Section on January 10, 1934, and published in the January, 1934, JOURNAL.

Clemens Herschel Award

The late Clemens Herschel, a former Past President and honorary member, gave to the Society a number of copies of his book on "Frontinus and the Water Supply of the City of Rome," with the request that the Board award one or more of the books each year as prizes for papers which have been particularly useful and commendable and worthy of grateful acknowledgment.

On recommendation of the Special Committee on Awards the Board voted to present a copy of this book to Karl R. Kennison, member, for his paper on "New Type of Open Flow Nozzle for Measurement of Sewage Flow," presented at a meeting of the Sanitary Section on December 6, 1933, and printed in the January, 1934, JOURNAL.

Social Activities

Six of the regular meetings of the year have been held at the Engineer's Club and one meeting at Chipman Hall, Tremont Temple, preceded by buffet suppers, under the direction of the Social Activities Committee. As usual, the most enthusiastic meeting was student night, held in November instead of February, and attended by members of the Student Engineering Societies of Massachusetts Institute of Technology, Harvard, Tufts and Northeastern University, at which time representatives of the musical clubs of the latter school assisted in the entertainment.

Library

The report of the Committee on Library contains a complete account of the library activities during the year.

Society Activities

The usual special committees dealing with the general activities and conduct of the Society have included the following: Program, Publication, Library, Social Activities and Membership and Publicity. Other special committees have included the following: Subsoils of Boston, Run-off, Research, Registration and Licensing of Engineers, Relation of Sections to the Main Society, Desmond FitzGerald Award and Prizes and John R. Freeman Fund and Welfare Committee. Each of these committees has made a distinct contribution to the Society and has developed fields of endeavor which will prove of great benefit to the members.

The Society has co-operated with the Engineering Societies of Boston, and many members of the Society have served on Engineering Societies' committees.

Your Board, in conclusion, wishes to express its appreciation of the excellent work done by the officers of the Sections and by the committees of the Society.

For the Board of Government,

ARTHUR W. DEAN, *President.*

Report of the Treasurer

BOSTON, March 10, 1934.

To the Boston Society of Civil Engineers:

Your treasurer submits the three appended tables: Table 1, presenting receipts and expenditures on account of the Society's eight funds; Table 2, recording investments and the income therefrom; and Table 3, summarizing the distribution of assets.

All interest and dividends of the Permanent Fund were transferred to the Current Fund. The following is a brief statement of current expenditures, year by year, and shows the extent to which they have been met by the transfer of Permanent Fund income:

	1929-30	1930-31	1931-32	1932-33	1933-34
Net expenditures (except such as provided for by appropriations from other than Permanent Fund income)	\$9,815	\$9,443	\$10,086	\$8,734	\$7,228
Members' dues received	7,794	8,028	7,045	6,030	5,540
Deficit	\$2,021	\$1,415	\$3,041	\$2,704	\$1,688
Transfer of Permanent Fund income to Current Fund	\$2,544	\$2,647	\$2,664	\$2,489	\$2,262

Unexpended income from the investments in funds other than the Permanent Fund has accumulated as follows:

John R. Freeman Fund	\$1,022 47
Edmund K. Turner Fund	13 02
Desmond FitzGerald Fund	112 16
Alexis H. French Fund	35 00
Clemens Herschel Fund	81 93
Edward W. Howe Fund	4 67

All securities have been carried on the books at their cost. Recent changes in the total amounts of the Society's two principal funds are as follows:

	March 1, 1930	March 1, 1931	March 10, 1932	March 10, 1933	March 10, 1934
Permanent Fund:					
Book value	\$48,688	\$49,108	\$50,081	\$50,263	\$50,348
Market value	—	53,457	46,488	42,937	46,029
John R. Freeman Fund:					
Book value	27,615	26,721	26,722	26,200	26,902
Market value	—	31,231	23,278	17,667	17,759

The total book value of all assets is \$95,633.28, of which \$9,905.11 is the estimated value of the library and furniture.

Respectfully submitted,

KARL R. KENNISON, *Treasurer.*

TABLE 1.—RECEIPTS AND EXPENDITURES

[Figures in parentheses are the Secretary's account numbers]

Current Fund

<i>Receipts</i>		
Balance March 10, 1933		\$1,652 28
Transferred from Permanent Fund income		2,261 72
Transferred from Clemens Herschel Fund income	(6)	1 15
Transferred from Edmund K. Turner Fund income	(44)	37 10
Meetings:		
Social activities	(13)	\$19 85
JOURNAL:		
Advertising	(34)	688 00
Sale of JOURNALS	(35)	156 01
Library:		
Fines	(45)	5 13
Miscellaneous:		
Badges	(51)	33 00
Binding JOURNALS for members	(52)	30 50
Total distributed receipts		\$932 49
Dues, including \$10 contributed	(70)	5,540 32
Total received from Secretary for Current Fund		6,472 81
		<u>\$10,425 06</u>

Expenditures

Office:		
Secretary — salary and expense	(1)	\$240 00
Stationery, printing and postage	(2)	181 61
Incidentals and petty cash	(3)	98 66
Insurance and Treasurer's bond	(4)	41 03
Safety deposit box	(5)	11 00
Prizes	(6)	1 15
Meetings:		
Rent of halls, etc.	(11)	209 00
Stationery, printing and postage	(12)	193 70
Social activities	(13)	118 40
Stereopticon	(15)	11 25
Annual meeting	(16)	71 40
Sections:		
Sanitary Section	(21)	21 00
Designers Section	(22)	42 99
Highway Section	(23)	17 90
Northeastern University Section	(24)	26 00
JOURNAL:		
Editor — salary and expense	(31)	369 00
Printing and postage	(32)	2,175 00
Advertising, commission, etc.	(34)	189 85

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Library:

Librarian — salary and expense	(41)	\$101 51
Periodicals	(43)	83 00
Binding	(44)	37 10

Miscellaneous:

Badges	(51)	33 00
Binding JOURNALS for members	(52)	27 00
Miscellaneous bank taxes, Treasurer's checking account	(54)	3 66

Total distributed expenditures		\$4,304 21
Engineering Societies of Boston	(59)	3,895 00
Balance March 10, 1934		\$8,199 21
		2,225 85
		\$10,425 06

Permanent Fund

Receipts

Balance March 10, 1933 — Investments		\$50,263 07
Income from investments:		
Interest:		
Bonds		\$910 00
Co-operative banks		551 63
Savings banks		226 88
Checking account		1 01
Dividends		572 20
Total interest and dividends		2,261 72
Entrance fees	(61)	85 00
		\$52,609 79

Expenditures

Income transferred to Current Fund		\$2,261 72
Balance March 10, 1934 — Investments		50,348 07
		\$52,609 79

John R. Freeman Fund

PRINCIPAL ACCOUNT

(No change during year)

Balance March 10, 1934:		
Investments		\$25,843 88
Cash		36 12
		\$25,880 00

INTEREST ACCOUNT

Receipts

Balance March 10, 1933		\$319 83
Dividends		1,308 24
		\$1,628 07

Expenditures

Traveling scholarships	(62)	\$605 60
Balance March 10, 1934		1,022 47

 \$1,628 07

Edmund K. Turner Fund

PRINCIPAL ACCOUNT

Receipts

Balance March 10, 1933 — Investments	\$993 75
Transferred from interest account	6 25

 \$1,000 00
Expenditures

None.

Balance March 10, 1934:

Investments	\$993 75
Cash	6 25

 \$1,000 00

INTEREST ACCOUNT

Receipts

Balance March 10, 1933	\$6 37
Interest — Bond	50 00

 \$56 37
Expenditures

Transferred to principal account	\$6 25
Transferred to Current Fund, account (44)	(63) 37 10
Balance March 10, 1934	13 02

 \$56 37

Desmond FitzGerald Fund

PRINCIPAL ACCOUNT

(No change during year)

Balance March 10, 1934 — Investments	\$2,005 00
--	------------

INTEREST ACCOUNT

Receipts

Balance March 10, 1933	\$112 16
Interest — Bonds	100 00

 \$212 16
Expenditures

Northeastern University scholarship	(64) \$100 00
Balance March 10, 1934	112 16

 \$212 16

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Alexis H. French Fund

PRINCIPAL ACCOUNT

Receipts

Balance March 10, 1933 — Investments	\$1,000 00
--------------------------------------	------------

Expenditures

None.

Balance March 10, 1934:

Investments	\$1,030 23	
Cash	—30 23	
		\$1,000 00

INTEREST ACCOUNT

Receipts

Balance March 10, 1933	\$4 77
Interest — Savings bank	30 23
	\$35 00

Expenditures

None.

Balance March 10, 1934	\$35 00
------------------------	---------

Clemens Herschel Fund

PRINCIPAL ACCOUNT

Receipts

Balance March 10, 1933 — Investments	\$1,000 00
--------------------------------------	------------

Expenditures

None.

Balance March 10, 1934:

Investments	\$1,035 30	
Cash	—35 30	
		\$1,000 00

INTEREST ACCOUNT

Receipts

Balance March 10, 1933	\$62 78
Interest — Savings bank	35 30
	\$98 08

Expenditures

Prize	\$15 00	
Transferred to Current Fund, account (6)	1 15	
	(66)	\$16 15
Balance March 10, 1934		81 93
		\$98 08

BOSTON SOCIETY OF CIVIL ENGINEERS

Edward W. Howe Fund

PRINCIPAL ACCOUNT

Receipts

Cash, December 2, 1933, by bequest	\$1,000 00
--	------------

Expenditures

None.

Balance March 10, 1934:

Investments	\$867 63
-----------------------	----------

Cash	132 37
----------------	--------

	\$1,000 00
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INTEREST ACCOUNT

Receipts

Interest — Executor	\$4 67
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Expenditures

None.

Balance March 10, 1934	\$4 67
----------------------------------	--------

TABLE 2.—RECORD OF INVESTMENTS
PERMANENT FUND

DURING THE YEAR MARCH 10, 1933—MARCH 10, 1934										MARCH 10, 1934		
	Date of Maturity or Classi- fication	Fixed or Current Interest Rate	MARCH 10, 1933—MARCH 10, 1934			SOLD OR MATURED		Par Value or Number of Shares	Market Value	Book Value		
			Interest or Dividends received	Additional Amount invested	Amount received	Profit on Sale						
Bonds												
American Tel. & Tel. Co.	Dec. 1, 1946	5 %	\$50 00	—	—	—	—	\$1,000 00	\$1,085 00	\$993 75		
Arkansas Water Co.	Oct. 1, 1956	5 %	50 00	—	—	—	—	1,000 00	920 00	1,005 00		
Chicago & Northwestern Ry. Co.	Nov. 1, 1987	5 %	50 00	—	—	—	—	1,000 00	845 00	1,102 50		
Connecticut River Power Co.	Oct. 1, 1952	5 %	100 00	—	—	—	—	2,000 00	2,050 00	1,927 50		
Illinois Power & Light Corp.	Dec. 1, 1956	5 %	50 00	—	—	—	—	1,000 00	627 50	981 25		
Kansas Power & Light Co.	Feb. 1, 1947	6 %	60 00	—	—	—	—	1,000 00	1,000 00	915 00		
Louisiana Power & Light Co.	Dec. 1, 1957	5 %	50 00	—	—	—	—	1,000 00	860 00	835 00		
Mississippi Power & Light Co.	Dec. 1, 1957	5 %	50 00	—	—	—	—	1,000 00	600 00	972 50		
Pennsylvania Power & Light Co.	Apr. 1, 1981	4½ %	45 00	—	—	—	—	1,000 00	935 00	970 00		
Public Electric Light Co.	Oct. 1, 1956	5½ %	110 00	—	—	—	—	2,000 00	1,500 00	1,975 00		
Southern Pacific Co.	Mar. 1, 1977	4½ %	45 00	—	—	—	—	1,000 00	810 00	955 00		
Tennessee Public Service Co.	Oct. 1, 1970	5 %	50 00	—	—	—	—	1,000 00	590 00	1,002 50		
Wheeling Electric Co.	May 1, 1941	5 %	200 00	—	—	—	—	4,000 00	4,140 00	3,845 00		
Total, Bonds	—	—	\$910 00	—	—	—	—	—	\$15,962 50	\$17,480 00		
Co-operative Banks												
Merchants Co-operative Bank	Dec. 1939	4½ %	\$99 60	\$459 60	—	—	—	30 Ser. 140	—	\$2,502 00		
Volunteer Co-operative Bank	Jan. 1936	4½ %	165 75	465 75	—	—	—	25 Ser. 135	—	3,980 00		
Volunteer Co-operative Bank	Mat. Shs.	4 %	80 00	—	—	—	—	\$2,000 00	—	2,000 00		
Watertown Co-operative Bank	Mat. Shs.	3½ %	206 28	143 28	—	—	—	{ 2,000 00	—	2,000 00		
Watertown Co-operative Bank	Mat. Sh. Credit	3½ %	—	—	\$1,210 51	—	—	{ 4,332 37	—	4,332 37		
Total, Co-operative Banks	—	—	\$551 63	\$1,068 63	\$1,210 51	—	—	—	\$14,814 37	\$14,814 37		

TABLE 2. — RECORD OF INVESTMENTS — Continued
PERMANENT FUND — Concluded

	DURING THE YEAR MARCH 10, 1933-MARCH 10, 1934					MARCH 10, 1934			
	Date of Maturity or Classi- fication	Fixed or Current Interest Rate	Interest or Dividends received	Additional Amount invested	SOLD OR MATURED		Par Value or Number of Shares	Market Value	Book Value
					Amount received	Profit on Sale			
Savings Banks									
Eliot Savings Bank, Boston	-	3½ %	\$121 31	\$121 31	-	-	-		\$3,558 09
Lynn Five Cents Savings Bank	-	3½ %	105 57	105 57	-	-	-		3,096 07
Total, Savings Banks	-	-	\$226 88	\$226 88	-	-	-	\$6,654 16	\$6,654 16
Stocks									
American Tel. & Tel. Co.	-	\$9 00	\$414 00	-	-	-	46	\$5,566 00	\$5,346 04
Consolidated Gas Co. of N. Y.	-	3 00	69 00	-	-	-	20	770 00	1,906 50
General Electric Co.	-	60	8 00	-	-	-	20	440 00	792 00
Radio Corporation of America	Com.	-	-	-	-	-	3½	26 67	845 00
New England Power Assoc.	Pref.	6 00	60 00	-	-	-	10	500 00	884 25
New York Central R.R. Co.	-	-	-	-	-	-	10	375 00	765 00
North American Trust	Cum., 1953	. 092	21 20	-	-	-	200	380 00	860 75
United States Steel Co.	Com.	-	-	-	-	-	10	540 00	
Total, Stocks	-	-	\$572 20	-	-	-	-	\$8,597 67	\$11,399 54
Cash	-	-	1 01	-	-	-	-	-	-
Total, Permanent Fund	-	-	\$2,261 72	\$1,295 51	\$1,210 51	-	-	\$46,028 70	\$50,348 07
JOHN R. FREEMAN FUND									
Stocks									
Alabama Power Co.	Cum. Pref.	\$7 00	\$70 00	-	-	-	10	\$490 00	\$980 00
American Superpower Corp.	Pref'nce	-	-	-	-	-	20	460 00	1,940 00
Carolina Power & Light Co.	Cum. Pref.	3 50	35 00	-	-	-	10	340 00	1,020 00
Commonwealth & Southern Corp.	Cum. Pref.	6 00	48 00	-	-	-	8	316 00	1,019 89
Commonwealth & Southern Corp.	Com.	-	-	-	-	-	25	62 50	

Consumers Power Co.	Cum. Pref.	6 00	60 00	-	-	-	10	740 00	1,020 00
Electric Power & Light Corp.	Cum. Pref.	-	-	-	-	-	10	140 00	1,076 20
Electric Power & Light Corp.	Com.	-	-	-	-	-	10	77 50	
Georgia Power Co.	Cum. Pref.	6 00	84 00	-	-	-	14	826 00	1,143 33
Minnesota Power & Light Co.	Pref.	3.50	43 80	-	-	-	10	440 00	980 00
Mississippi River Power Co.	Cum. Pref.	6 00	60 00	-	-	-	10	840 00	900 00
Montreal Light, Heat & Power Cons.	Com.	1 50	87 92	-	-	-	66	2,376 00	1,497 68
New England Power Assoc.	Pref.	6 00	60 00	-	-	-	10	500 00	970 00
New England Power Co.	Pref.	6 00	60 00	-	-	-	10	930 00	960 00
Northwestern Electric Co.	Cum. 1st Pr.	-	-	-	-	-	10	160 00	980 00
Pacific Gas & Electric Co.	Cum. 1st Pr. 6%	1 50	90 00	-	-	-	60	1,320 00	1,922 02
Pacific Gas & Electric Co.	1st Pr. 5½%	1 375	27 52	-	-	-	20	400 00	
Pacific Gas & Electric Co.	Com.	1 50	112 00	-	-	-	64	1,232 00	1,808 79
Penn. Gas & Elec. Corp.	Pref.	7 00	210 00	-	-	-	30	1,620 00	2,955 00
Southern Cal. Edison Co.	Cum. Orig. Pr.	2 00	80 00	-	-	-	40	1,360 00	1,161 22
Southern Cal. Edison Co.	Com.	2 00	40 00	-	-	-	20	360 00	539 75
The Tenn. Elec. Power Co.	1st Pref.	7 00	70 00	-	-	-	10	440 00	950 00
Utah Power & Light Co.	Cum. Pref.	-	-	-	-	-	10	200 00	990 00
West Penn Power Co.	Cum. Pref.	7 00	70 00	-	-	-	10	1,070 00	1,030 00
Total Stocks	-	-	\$1,308 24	-	-	-	-	\$16,700 00	\$25,843 88
Cash:	-	-	-	-	-	-	-	36 12	36 12
Principal account	-	-	-	-	-	-	-	1,022 47	1,022 47
Interest account	-	-	-	-	-	-	-	-	-
Total, John R. Freeman Fund	-	-	\$1,308 24	-	-	-	-	\$17,758 59	\$26,902 47

EDMUND K. TURNER FUND

American Tel. & Tel. Co.	Bonds	Dec. 1, 1946	5 %	\$50 00	-	-	\$1,000 00	\$1,085 00	\$993 75
Total, Bonds		-	-	\$50 00	-	-	-	\$1,085 00	\$993 75
Cash:		-	-	-	-	-	-	6 25	6 25
Principal account		-	-	-	-	-	-	13 02	13 02
Interest account		-	-	-	-	-	-	-	-
Total, Edmund K. Turner Fund		-	-	\$50 00	-	-	-	\$1,104 27	\$1,013 02

TABLE 2. — RECORD OF INVESTMENTS — *Concluded*
 DESMOND FITZGERALD FUND

	DURING THE YEAR MARCH 10, 1933-MARCH 10, 1934					MARCH 10, 1934			
	Date of Maturity or Classi- fication	Fixed or Current Interest Rate	Interest or Dividends received	Additional Amount invested	SOLD OR MATURED		Par Value or Number of Shares	Market Value	Book Value
					Amount received	Profit on Sale			
Bonds									
Central Power & Light Co. . .	Aug. 1, 1956	5 %	\$50 00	-	-	-	\$1,000 00	\$567 50	\$1,005 00
Southwestern Gas & Elec. Co. .	Jan. 1, 1957	5 %	50 00	-	-	-	1,000 00	822 50	1,000 00
Total, Bonds . . .	-	-	\$100 00	-	-	-	-	\$1,390 00	\$2,005 00
Cash — Interest account . . .	-	-	-	-	-	-	-	112 16	112 16
Total, Desmond Fitzgerald Fund	-	-	\$100 00	-	-	-	-	\$1,502 16	\$2,117 16
ALEXIS H. FRENCH FUND									
Savings Banks									
Boston Five Cents Savings Bank .	-	3 %	\$30 23	\$30 23	-	-	-	-	\$1,030 23
Total, Savings Banks . . .	-	-	\$30 23	\$30 23	-	-	-	\$1,030 23	\$1,030 23
Cash:	-	-	-	-	-	-	-	-	-
Principal account . . .	-	-	-	-	-	-	-	-	-
Interest account . . .	-	-	-	-	-	-	-	-	-
Total, Alexis H. French Fund	-	-	\$30 23	\$30 23	-	-	-	\$1,035 00	\$1,035 00

CLEMENS HERSCHEL FUND

Savings Banks									
Charlestown Five Cents Savings Bank	-	-	3½%	\$35 30	\$35 30	-	-	-	\$1,035 30
Total, Savings Banks	-	-	-	\$35 30	\$35 30	-	-	-	\$1,035 30
Cash:									
Principal account	-	-	-	-	-	-	-	-	-35 30
Interest account	-	-	-	-	-	-	-	-	81 93
Total, Clemens Herschel Fund	-	-	-	\$35 30	\$35 30	-	-	-	\$1,081 93

EDWARD W. HOWE FUND

Co-operative Banks									
Received December 2, 1933	-	-	-	\$4 67	\$867 63	-	\$1,000 00	-	-
Watertown Co-operative Bank	-	-	3½%	-	-	-	-	-	\$867 63
Total, Co-operative Banks	-	-	-	-	\$867 63	-	-	-	\$867 63
Cash:									
Principal account	-	-	-	-	-	-	-	-	132 37
Interest account	-	-	-	-	-	-	-	-	4 67
Total, Edward W. Howe Fund	-	-	-	\$4 67	\$867 63	-	\$1,000 00	-	\$1,004 67

ALL FUNDS

Total, Investment Funds	-	-	-	\$3,790 16	\$2,228 67	\$1,210 51	\$1,000 00	-	\$69,515 32	\$83,502 32
Cash in Current Fund	-	-	-	-	-	-	-	-	2,225 85	2,225 85
Total, Funds	-	-	-	-	-	-	-	-	\$71,741 17	\$85,728 17

TABLE 3. — DISTRIBUTION OF ASSETS, MARCH 10, 1934

	Current Fund	INVESTMENTS						Inventory	Total
		Permanent Fund	John R. Freeman Fund	Edmund K. Turner Fund	Desmond FitzGerald Fund	Alexis H. French Fund	Clemens Herschel Fund	Edward W. Howe Fund	
<i>Assets</i>									
Bonds	—	\$17,480 00	—	\$993 75	\$2,005 00	—	—	—	\$20,478 75
Co-operative banks	—	14,814 37	—	—	—	—	—	\$867 63	15,682 00
Savings banks	—	6,654 16	—	—	—	\$1,030 23	\$1,035 30	—	8,719 69
Stocks	—	11,399 54	\$25,843 88	—	—	—	—	—	37,243 42
Cash:									
Principal account	—	—	36 12	6 25	—	—	—	132 37	109 21
Interest account	\$2,225 85	—	1,022 47	13 02	112 16	35 00	81 93	4 67	3,495 10
Total Funds — Book value (Market value)	\$2,225 85 (2,225 85)	\$50,348 07 (46,028 70)	\$26,902 47 (17,758 59)	\$1,013 02 (1,104 27)	\$2,117 16 (1,502 16)	\$1,035 00 (1,035 00)	\$1,081 93 (1,081 93)	\$1,004 67 (1,004 67)	\$85,728 17 (71,741 17)
Library and furniture	—	—	—	—	—	—	—	—	9,905 11
Total Assets — Book value	—	—	—	—	—	—	—	—	\$95,633 28
<i>Liabilities</i>									
None.									
<i>Corresponding Totals in Previous Years</i>									
Book value:									
March 10, 1933	\$1,652 28	\$50,263 07 (42,937 03)	\$26,199 83 (17,666 70)	\$1,000 12	\$2,117 16	\$1,004 77	\$1,062 78	\$9,905 11	\$93,205 12
(Market value)									
March 10, 1932	1,867 02	50,080 87	26,721 54	1,017 22	2,317 16	1,040 40	1,042 07	9,905 11	93,991 39
March 1, 1931	2,244 24	49,108 37	26,721 33	1,007 92	2,217 16	1,000 00	1,000 00	9,905 11	93,204 13
March 1, 1930	1,011 64	48,688 37	27,614 81	1,019 37	2,217 16	—	—	9,905 11	90,456 46

REPORT OF AUDITING COMMITTEE FOR YEAR 1933-34

BOSTON, March 17, 1934.

We have examined the accounts of the Treasurer of the Boston Society of Civil Engineers and find the books properly kept and the various expenditures of the past year supported by duly approved receipts.

The Treasurer has also accounted to us for the investments and cash on hand, as submitted in the above report.

JOHN C. MOSES,
HARRY P. BURDEN,
*Auditing Committee of the Directors of the
Boston Society of Civil Engineers.*

Report of the Secretary

BOSTON, March 21, 1934.

EVERETT N. HUTCHINS, Secretary, *in Account with the BOSTON SOCIETY OF CIVIL ENGINEERS, Dr.*

For cash received during the year ending March 21, 1934:

Entrance fees, new members and transfers:

Six new members, 3 juniors and 2 juniors transferred to the grade of member	\$85 00
Annual dues for 1933-34, including dues from new members	\$5,175 32
Back dues	313 00
Advance dues for 1934-35	42 00
Contribution	10 00
Total from dues	5,540 32
Advertisements	688 00
Sale of JOURNALS	156 01
Library fines	5 13
Sales of badges	33 00
Binding JOURNALS for members	30 50
Social Activities Committee (smokers)	19 85
Total receipts	\$6,557 81

The above amount has been paid to the Treasurer, whose receipt to the Secretary holds.

The appended table shows the expenditures for the year.

EVERETT N. HUTCHINS, *Secretary.*

Account
Number

EXPENDITURES FOR YEAR 1933-34

Office:

1. Secretary, salary and expense	\$240 00
2. Stationery, printing, postage	181 61
3. Incidentals and petty cash	98 66
4. Insurance and Treasurer's bond	41 03
5. Safety deposit box	11 00

\$572 30

Meetings:

11. Rent of halls	\$209 00
12. Stationery, printing, postage	193 70
13. Social activities (net)	98 55
14. } Reporting and stereopticon	11 25
15. }	
16. Annual meeting (1933)	71 40

583 90

Sections:

21. Sanitary Section	\$21 00
22. Designers Section	42 99
23. Highway Section	17 90
24. Northeastern University Section	26 00

107 89

JOURNAL:

31. Editor, salary and expense	\$369 00
32. Printing and postage	2,175 00

2,544 00

Library:

41. Librarian, salary and expense	\$101 51
43. Periodicals	83 00

184 51

Dues:

59. Dues to Engineering Societies	3,895 00
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Total	\$7,887 60
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REPORT OF AUDITING COMMITTEE FOR YEAR 1933-34

MARCH 17, 1934.

We have examined the records and accounts of the Secretary of the Boston Society of Civil Engineers and have satisfied ourselves that they are properly kept, and that the money received has been transferred to the Treasurer.

JOHN C. MOSES,
HARRY P. BURDEN,
*Auditing Committee of the Directors of the
Boston Society of Civil Engineers.*

Report of the Editor

BOSTON, February 10, 1934.

To the Board of Government, Boston Society of Civil Engineers:

The Editor submits the following report for the calendar year 1933 (Volume XX) of the JOURNAL.

During the year 1933 there have been published ten papers presented at meetings of the Society and Sections; three other articles; and two memoirs of deceased members. The December issue contains the Contents and Index for the year.

The nine issues of the JOURNAL (February and March were combined) contained 331 pages; an average of 1,246 copies of each issue were printed. The net cost was \$1,380.36, as compared with \$2,600.62 for the preceding year.

Table I includes a comparison of the costs for the JOURNAL from 1929-33, inclusive. In Table II details of cost for Volume XX of the JOURNAL for the calendar year 1933 are shown.

Respectfully submitted,

EVERETT N. HUTCHINS, *Editor.*

TABLE I. — COMPARISON OF COSTS OF JOURNAL, 1929-33, INCLUSIVE

YEAR	Volume	Number of Pages*	GROSS COST†		NET COST‡		Number of Cuts and Inserts
			Total	Per Page	Total	Per Page	
1929 . . .	XVI	641	\$4,525 79	\$7 06	\$2,854 17	\$4 45	116
1930 . . .	XVII	723	5,107 16	7 06	3,812 86	5 27	167
1931 . . .	XVIII	515	3,916 95	7 60	2,634 18	5 11	99
1932 . . .	XIX	633	3,906 87	6 17	2,600 62	4 10	108
1933 . . .	XX	331	2,265 51	6 84	1,380 36	4 17	82

* Includes Advertising Section and Annual Index.

† Gross cost included editing, printing and mailing.

‡ Net cost equals gross cost less amounts received for advertising, subscriptions and sales of JOURNALS.

Report of the Committee on Membership and Publicity

BOSTON, March 15, 1934.

To the Boston Society of Civil Engineers:

The activities of the Committee on Membership and Publicity during the past year have been largely along the lines of watchful and hopeful waiting.

To have undertaken a membership campaign during the past year might have proved more irritating than effective. Through the activities of the Engineering Societies of Boston, in the form of their weekly bulletin, the matter of publicity has not been entirely ignored.

The Board of Government has called on this Committee from time to time to consider matters of policy affecting membership, and reports have been made accordingly.

Respectfully submitted,

Committee on Membership and Publicity,

A. B. EDWARDS, *Chairman*.

Report of the Committee on Social Activities

BOSTON, March 15, 1934.

To the Boston Society of Civil Engineers:

Six meetings of the Society have been held during the year at the Engineer's Club. The student night was held at Chipman Hall, Tremont Temple, and the outing at Wayland. The student night this year was held in November, 1933, in order to interest students earlier in their school year.

The largest attendance at buffet suppers was 188 (student night) and the smallest was 46. The total number attending the suppers was 623.

The Society is now being charged \$1 for the buffet lunches at the Engineer's Club, 50 cents of which is paid by the members and the remainder by the Society. In view of the financial condition of the Society it is felt that other arrangements should be made.

Respectfully submitted,

EDWARD S. AVERELL, *Chairman*.

Report of the Committee on Relation of Sections to the Main Society

BOSTON, March 21, 1934.

To the Boston Society of Civil Engineers:

This Committee was established three years ago in order to co-ordinate the activities of the Society and of its four Sections, — the Sanitary Section, the Designers Section, the Highway Section and the Northeastern University Section. Its personnel

includes the four Section chairmen, together with one or more members to represent the main Society. During the past year its work has consisted of (1) co-ordination of the program of section meetings; (2) co-operation with the Engineering Societies of Boston with regard to the meeting notices which are published in the new weekly Journal of the Engineering Societies; and (3) consolidation of the By-Laws of the individual Sections.

(1) As soon as the Program Committee of the main Society and the Executive Committees of the individual Sections have outlined their tentative programs for meetings for the coming year, this Committee studies these programs with a view to suggesting changes if there appear to be duplications or cases of overlapping of subject matter. As a result it is possible to secure modifications which will provide a better co-ordinated program and to arrange for joint meetings whereby the interests of the membership as a whole will be served more effectively.

(2) During the past year the Journal of the Engineering Societies of Boston has been changed from a monthly to a weekly Journal. The monthly Journal had not provided satisfactory publicity for announcement of meetings, and each member Society and Section had been sending out individual meeting notices. With the approval of the individual Societies a weekly Journal was established early in the fall of 1933, and this new publication has been found satisfactory as a publicity medium and individual meeting notices have been eliminated almost entirely. Through co-operation with the Engineering Societies of Boston Journal, under the auspices of this Committee, the Sections have received excellent publicity for their meetings. This consisted of advance notices published in the inside pages of the Journal, followed by displayed notices on the front cover for the week in which the meetings are to take place. It is the consensus of opinion of the officers of the Boston Society of Civil Engineers Sections that this method of publicity has been very effective as judged by the attendance at meetings throughout the year just ended.

(3) Formerly each Section had its own By-Laws, which had been approved by the Section and by the Board of Government of the Society. A study of these By-Laws showed them to be very much alike, the only differences being of a minor character. As a result it seemed appropriate to prepare a standard set of Section By-Laws, applicable to all the Sections. Such a change would simplify the situation with respect to the individual Sections as well as provide economy in the publication of the By-Laws, which is planned for the April (quarterly) JOURNAL of the Society. Through this Committee, a consolidated set of Section By-Laws was prepared, and these now have been approved by all the Sections and by the Board of Government.

Respectfully submitted,

For the Committee,

J. B. BABCOCK, *Chairman.*

Report of the Committee on Welfare

BOSTON, March 21, 1934.

To the Boston Society of Civil Engineers:

As the matter of welfare of members of this Society is under the direction of the Emergency Planning and Research Bureau, Inc., it has not been necessary for this Committee to meet or transact any business during the year.

Respectfully submitted,

H. K. BARROWS, *Chairman.*

Report of the Library Committee

BOSTON, March 15, 1934.

To the Boston Society of Civil Engineers:

The Report of the Library Committee for the year 1933-34 is submitted by the Librarian in the absence of the chairman.

During the year 188 books have been loaned and \$5.13 in fines have been collected.

The Board of Government found it necessary to ask this Committee to curtail expenses. After much deliberation, a number of periodicals were eliminated from the subscription list and also from the list of those which are usually bound. Also, in view of the immediate financial status of the Society, the current issues of one-half of the remaining periodicals are unbound, although the budget allotment is not used up. Some of these numbers have been lost and members are asked to be a little more careful in their use.

Through the kindness of Prof. C. Frank Allen, another copy of his "Business Law for Engineers" has been donated to the Library. This replaces two copies which have been stolen. This copy is not to be taken from the Library.

This is the second consecutive year in which no new books have been purchased.

Society publications and periodicals have been rearranged in the Library in order to accommodate those which are considered of sufficient importance to have bound.

Respectfully submitted,

EDWARD S. AVERELL, *Librarian.*

Report of the Publication Committee

BOSTON, March 20, 1934.

To the Boston Society of Civil Engineers:

The Publication Committee was confronted with the necessity of meeting a reduced budget figure for the publication of the JOURNAL. The result was a thin JOURNAL. The Committee has been obliged to forego or defer publishing some papers involving

extensive printing. The briefer papers published have furnished a variety of subjects, and their publication had been urged by various members of the Society.

This committee recommended the adoption of a JOURNAL to be issued quarterly, which the Board of Government approved. The January issue is the first under that plan. It is believed that this form will be more economical, but it is the intention of the Committee that as many papers as possible shall be published as the funds permit.

Respectfully submitted,

Publication Committee,

J. B. BABCOCK,
G. M. FAIR,
H. M. TURNER,
J. S. CRANDALL,
E. N. HUTCHINS, *Chairman.*

Report of the Committee on Run-off

LOWELL, March 6, 1934.

To the Boston Society of Civil Engineers:

This statement is submitted as a progress report of the Committee on Run-off which was appointed on March 18, 1931, by President Moore and reappointed by successive presidents each year.

The Committee was appointed to continue the work of the October, 1922, report, and to study the recent severe drought which, beginning with the summer of 1929, continued through the next three years.

Any formal report has been delayed for a number of reasons, but principally because of the duration of the dry period and the hope that more nearly normal conditions of precipitation and run-off would obtain.

The drought period was at least three years long, and similar to the 1908-1910 drought, which brought forth the report of the former Committee of which Mr. F. P. Stearns was chairman.

Based upon long-term records at Lowell, Mass., the lowest three-year continuous records are as follows:—

	Inches
1864-1866	40.279
1882-1884	38.156
1894-1896	39.850
1908-1910	35.652
1911-1912	36.624
1912-1914	38.659
1917-1919	38.769
1929-1931	35.980

In this period of 68 years, or two-thirds of a century, the lowest continuous three years, 1908-1910, of 35.65 inches are but 0.328 of an inch below 1929-1931.

When it is considered that an average rainfall of 42 inches ordinarily produces

nearly 21 inches of run-off, or 50 per cent; 35 inches but 14 inches, or 40 per cent; and a single year like 1930, with but 31.155 inches of rainfall, a run-off of only 10 inches, or 30 per cent — years like these not only test the capacity of water supplies, but reduce our rivers to but a fraction of their normal flow.

A single year of low precipitation may not exhaust the ground water, but coming after several below-normal years, they are likely to dry up the small and medium-sized streams which are without storage.

The Committee has attempted to get some long-term ground water records, because of their value to any study of ground water yield, and consequently flows, during what are commonly called dry times, but they appear to be difficult to obtain for any large areas. For this reason the value of continuous years of low rainfall and corresponding run-off become important, and much attention has been given to studying and compiling these records.

A brief statement of precipitation for the years beginning with 1921, since the report of this former committee, follows:

ANNUAL PRECIPITATION FOR NEW ENGLAND

YEAR	Inches of Precipitation	Remarks
1921	37.53	3.91 below normal
1922	42.80	1.36 above normal
1923	40.05	1.42 below normal
1924	35.62	5.78 below normal
1925	41.23	0.69 above normal
1926	39.19	2.70 below normal
1927*	45.63	3.99 above normal
1928	40.25	0.93 below normal
1929	39.55	2.35 below normal
1930	34.11	7.61 below normal
1931	41.28	0.40 below normal
1932	43.61	2.18 above normal
1933	44.70	3.18 above normal

* The year of the disastrous floods (in November).

From 1921 to 1927 there were four years below and three years above the average; but beginning with 1928, four out of six years were below normal.

To make this period of thirteen years still more interesting and the records valuable for the future, New England has just been through the coldest winter since that of 1917-1918, and the winter drought on some streams was unusually severe.

With regard to the progress of a report from this Committee, through the courtesy of Mr. H. B. Kinnison, a member of the Committee, the records of the United States Geological Survey are available to the members of the Committee; and to give work to unemployed engineers much of the detail work of duration curves, hydrographs, etc., has been carried well along.

It is hoped that a complete report can be given to the Society at the meeting in March, 1935.

Much of the work of the Committee inevitably will be a repetition of the studies of the 1921 report, but based upon the records of precipitation and run-off brought up to date, and will not conflict with the many papers by individuals and departments on special features of the happenings during the twelve years since 1921.

Former Committee studies and reports on the capacity of water supplies and streams as tested by the dry periods of the early 80's and 1908-1910 were based upon Cochituate and Sudbury records of the Boston Water Works and the Wachusett records of the Metropolitan Water Supply; but there were very few good, long-term river flow records prior to 1912. In order to make available the great number of stations of the United States Geological Survey and their records, the Committee is now in a position to analyze the larger streams and make the records as valuable for water power as well as water works officials. Probably the greatest contribution which this Committee can make is to establish from published records this period of 1929-1932 as one of the very driest of a century; which, if a fact, makes the flow records for these years something approaching a minimum for the long future.

Respectfully submitted,

Committee on Run-off,

ARTHUR T. SAFFORD, *Chairman.*

Report of the Committee on Subsoils of Boston

BOSTON, March 21, 1934.

To the Boston Society of Civil Engineers:

The general purpose of this Committee is to gather data regarding the character of the subsoils of Boston and vicinity, and to present it to the Society in such form as to make it valuable for reference to any who may wish to gain a clear idea of the geological construction of the subsoils.

In the September number of the 1931 JOURNAL there was published a rather extensive progress report of the Committee's work, and since that time we have had the help of men employed by the Emergency Planning and Research Bureau, Inc.

In June, 1932, work was started on the task of increasing the test boring records being collected by the Subsoil Committee, starting with the records as published by the Committee in September, 1931.

At first, one man from the Emergency Planning and Research Bureau was used, and the force was steadily increased until, during a greater part of the year 1933, an average of four men were at work, five days a week. At the present time the C. W. A. has taken most of the men on the Bureau pay roll, so that now only one man is at work on a basis of part time, bringing the work to a close.

The work accomplished to date is as follows:

In 1931 the Committee had five maps showing locations of 908 groups of borings. There are now fourteen maps nearly finished showing something better than 6,000

boring records and about 1,100 excavation records, an increase of nearly 6,200 records. These are distributed as follows:

Map No.	DISTRICT	Test Borings	Excavations
1	Boston Peninsula	1,400	20
2	Roxbury	900	150
3	South Boston	603	10
4	East Boston	429	—
5	Cambridge	600	—
6	Brighton	211	80
7	Charlestown	200	1
8	Dorchester	384	265
9	West Roxbury	186	204
10	Hyde Park	4	72
11	Somerville	136	134
12	Everett	134	170
13	Brookline	332	—
14	Chelsea	37	6
	Total	5,556	1,112

Some of the record cards give several test borings in one location which gives better than 6,000 tests shown on the 5,541 cards given above.

Of the above maps, those numbered 1, 4, 6, 7, 8, 9, 10, 12 and 14 are complete. The others will require some further careful checking and revisions.

Nearly all of the records have been written up in final form on the 4 inch by 6 inch printed file cards of the Subsoil Committee. A 6-drawer file cabinet was purchased in which the completed file is kept. This will be placed in the Library of the Society when the work is completed.

Some work has been done on the improvement and increased accuracy of the cross sections of the overburden made by the Committee across various parts of Boston. These will be checked against the much greater number of records that are now available. Several new sections are contemplated and preliminary studies made of them.

All of this work will be completed some time in the first half of this year, and will be made ready for publication at any time the Society can do so.

The data, showing the general subsoil conditions under Boston and vicinity, will be very much more complete and useful than the "Progress Report" of 1931, and should be called final. It will be many years before enough data can be collected to make another revision desirable.

In addition, Mr. Irving B. Crosby is independently preparing a map to show the topography of the bedrock surface. He is also preparing geological sections of the foundations using data collected by the Committee. The map and sections will be published by the Society and will be accompanied by an article explaining the geology. This will supplement and interpret the data collected by the Committee.

The Committee should be continued until the work under way is completed and as outlined above and the final report written.

We believe that the added knowledge of the subsoil conditions under Boston will be valuable in many ways, especially during the years to come, when prosperity returns and active construction of large buildings and other structures is resumed.

Such data as we have collected are also valuable if they be used in the economical selection of sites for buildings which are heavy or having deep basements.

The location of proposed buildings, such as hospitals and laboratories, requiring firm foundations and freedom from evil effects of earthquake tremors, should be strongly influenced by such data as we have presented, as the areas of firm soils and rock, as well as the softer soils, are shown.

Respectfully submitted,

For the Committee,

HARRY E. SAWTELL, *Chairman.*

Report of the Executive Committee of the Sanitary Section

BOSTON, March 7, 1934.

To the Sanitary Section, Boston Society of Civil Engineers:

During the past year five meetings were held, as follows:

March 1, 1933. — Annual meeting. "Sewer Assessment Practice in Massachusetts," by Paul F. Howard of Whitman and Howard; *attendance*, 36.

June 3, 1933. — Inspection trip of construction work at Newton High-Level Sewer and Newton Water Pumping Station; *attendance*, 31.

October 4, 1933. — Regular meeting. "Chasing Pollution in Puget Sound," by Stephen DeM. Gage; *attendance*, 23.

December 6, 1933. — Regular meeting. "Measurement of Sewage Flow by New Type Open Nozzle," by Karl R. Kennison, Designing Engineer, Metropolitan District Water Supply Commission; and "Measurement of Sewage Flow by the Parshall Flume," by Charles G. Richardson, Sales Engineer, Builders Iron Foundry, Providence, R. I.; *attendance*, 50.

February 7, 1934. — Special meeting. "A Comparative Study of Certain Presumptive Test Media for Bacteriological Water Analysis," by Dr. Murray P. Horwood, Massachusetts Institute of Technology; *attendance*, 24.

Attendance. — Attendance at meetings has varied from 23 to 50, with an average of 33.

Membership. — The present membership of the Section is 194. During the past year 3 new members were added to the roll, 6 were lost by resignation, and 1 by death.

Executive Committee Meetings. — Six meetings of the Executive Committee were held during the past year.

Respectfully submitted,

For the Executive Committee,

FRANK L. FLOOD, *Clerk.*

Report of the Executive Committee of the Designers Section

BOSTON, March 14, 1934.

To the Designers Section, Boston Society of Civil Engineers:

During the past year eight regular meetings of the Section have been held, as follows:

March 8, 1933. — Annual meeting, election of officers. "Unsymmetrical Concrete Arches," by Prof. Frederic N. Weaver of Tufts College; *attendance*, 40.

April 12, 1933. — "Depression Hallucinations and Facts," by Dr. Raymond V. Phelan of Tufts College; *attendance*, 20.

May 10, 1933. — "Technical Details of the Structural Design of the French King Bridge," by A. E. Kleinert, Assistant Structural Engineer, Massachusetts Department of Public Works; *attendance*, 22.

October 11, 1933. — "Under Water Operations," by J. Stuart Crandall of the Crandall Engineering Company; *attendance*, 38.

November 8, 1933. — "Current Developments in Foundation Engineering and Soil Mechanics," by Dr. Arthur Casagrande of Harvard University; *attendance*, 40.

December 13, 1933. — "Structural Features of Theatre Design," by Mark Linenthal, Structural Engineer, Boston; *attendance*, 25.

January 10, 1934. — "A New Method for Analyzing Stresses due to Lateral Forces in Building Frames," by J. E. Wilbur of Massachusetts Institute of Technology; *attendance*, 39.

February 14, 1934. — "Methods and Progress in Aerial Photography," by Capt. Albert W. Stevens, Head of Experimental Photography, Division of United States Army Air Corps, Wright Field, Dayton, Ohio.

This was a joint meeting of the Designers Section and the Boston Society of Civil Engineers, held at the Institute of Geographical Exploration at Harvard University. Approximately 225 were present.

The average attendance during the past year was 56. The membership in March, 1933, was 174. During the year 4 new members were added, 1 resigned, leaving a net membership of 177.

Respectfully submitted,

For the Executive Committee,

HENRY BRASK, *Clerk.*

Report of the Executive Committee of the Highway Section

BOSTON, February 28, 1934.

To the Highway Section, Boston Society of Civil Engineers:

During the past year three meetings have been held.

March 15, 1933. — Annual meeting, election of officers; *attendance*, 15.

April 26, 1933. — "The Development of Highway Grade Separations in Massachusetts," by James H. O'Connor, Senior Structural Engineer, Massachusetts Department of Public Works; *attendance*, 22.

November 22, 1933. — "Highway Accidents," by Clarence P. Taylor, Traffic Engineer, Massachusetts Department of Public Works; *attendance*, 70.

The average attendance was 36.

During the year 4 members were added and 2 resigned. The present membership is 102.

Respectfully submitted,

For the Executive Committee,

ARTHUR P. RICE, *Clerk*.

Report of the Executive Committee of the Northeastern University Section

BOSTON, February 27, 1934.

To the Boston Society of Civil Engineers:

The Northeastern University Section has held four meetings during the year, as follows:

May 4, 1933. — Annual meeting. "The Lucerne Project in Quebec," by Prof. Charles B. Breed; *attendance*, 34.

October 4, 1933. — "Bridge Erection Problems," by John C. Moses, Chief Engineer, Boston Bridge Works; *attendance*, 26.

December 14, 1933. — "The Field of Sanitary Engineering," by Prof. Thomas R. Camp, Massachusetts Institute of Technology; *attendance*, 17.

February 27, 1934. — "Personal Experiences at the Boston Navy Yard during the War," by Emil A. Graustorff, Associate Professor of Civil Engineering, Northeastern University; *attendance*, 12.

Membership. — At present there are 223 members in the Section.

Attendance. — The average attendance has been 22.

Respectfully submitted,

For the Executive Committee,

BRUCE SCHOW, *Clerk*.

BOSTON SOCIETY OF CIVIL ENGINEERS
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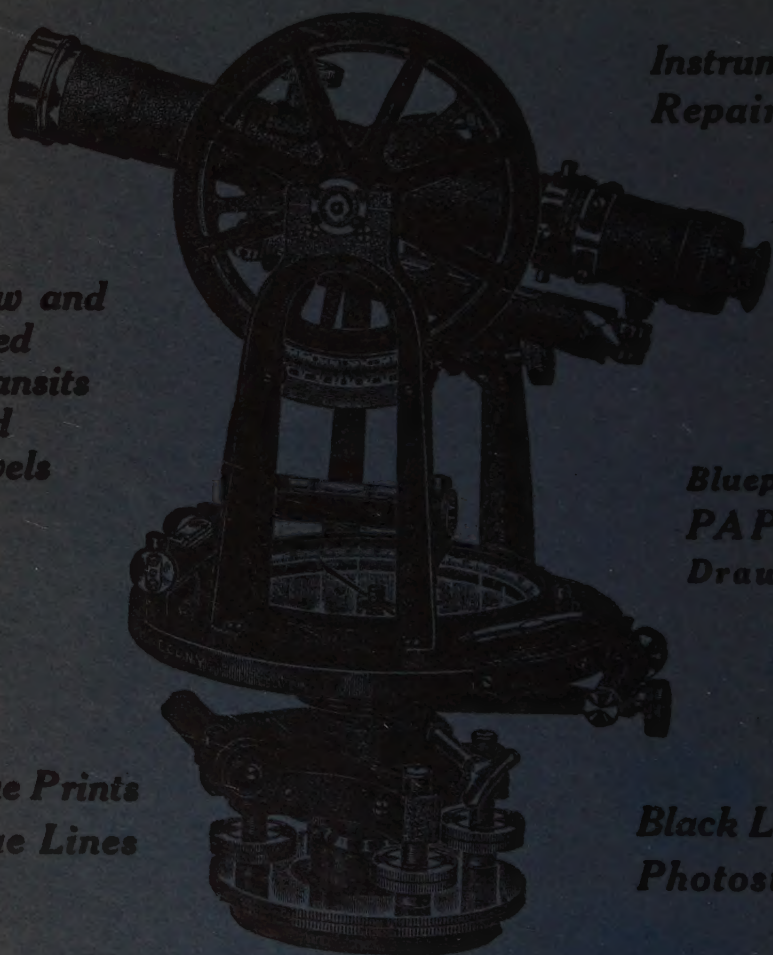
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